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Maine Geological Survey, Geophysics and Geological Survey (GP&G Survey); Mineral Resources Reference Map; Special Geologic Studies Series. Augusta, Maine.
Military Engineer (Society of American Military Engineers). Washington, D. C.
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PURCHASE OF PUBLICATIONS

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GeoScience Abstracts

1. GEOLOGIC MAPS, AREAL AND REGIONAL GEOLOGY

PART 1. GEOLOGIC MAPS

See also: Areal and Regional Geology 1-2180; Fuels 1-2387.

1-2155. MAP OF GEOIDAL CONTOURS: Military Engineer, v. 51, no. 343, p. 406, map, Sept.-Oct. 1959.

The U. S. Army Map Service has constructed a geoidal contour map of North America at a scale of 1:2,000,000 and contours at 1-m. intervals. A very small scale generalization of that map, with contours at 5-m. intervals, illustrates that the North American geoid has a big depression in the northern half of the continent centered in Hudson Bay. To the E., the geoid rises toward Greenland and Newfoundland; to the W. is a ridge at about 120°W. separating the big depression from smaller ones farther W. --M. Russell.

1-2156. Lathram, E. H., R. A. Loney, W. H. Condon, and H. C. Berg. PROGRESS MAP OF THE GEOLOGY OF THE JUNEAU QUADRANGLE, ALASKA: U. S. Geol. Survey, Misc. Inv. Map I-303, scale 1:250,000, 1959.

This map and explanation show the reconnaissance geology of about 3,400 sq. mi. S. and W. of Juneau in southeastern Alaska. The geology compiled to date, largely as a result of mapping under the U. S. Geological Survey's long-range minerals program, is delineated on a 1:250,000 planimetric base. The map also indicates the location of both previously known and newly discovered sites of mineralization. The new map includes field work done during 1958 and supersedes map I-276. --U. S. Geol. Survey.

1-2157. Wells, John D. PRELIMINARY GEOLOGIC MAP OF THE HOUSE ROCK SPRING SE QUADRANGLE, COCONINO COUNTY, ARIZONA: U. S. Geol. Survey, Mineral Inv. Map MF-189, scale 1:24,000, contour interval 40 ft., lat. 36°45'-36°52'30"N., long. 112°00'-112°07'30"W., 1959.

1-2158. Hanley, John B. POLAND, MAINE. SURFICIAL GEOLOGY: U. S. Geol. Survey, Geol. Quad. Map GQ-120, scale 1:62,500, contour interval 20 ft., lat. 44°-44°15'N. long. 70°15'-70°30'W., 1959.

The surficial deposits of the quadrangle are chiefly glacial in origin; a Pleistocene marine deposit is of smaller extent. Small alluvial, swamp, and dune deposits are of Recent age. Glacial erosional features on bedrock are indicated on the map. The glacial deposits include 2 types of ground moraine, moraines, kames and kame fields, eskers, kame terraces, kame deltas, and outwash sands. Clays, sands, and gravels in the surficial deposits are of commercial importance. --U. S. Geol. Survey.

1-2159. Doyle, Robert G. MINERAL RESOURCES OF MAINE - PORTLAND-BATH SHEET: Maine Geol. Survey, Mineral Resources Reference Map 3, scale approx. 1 in. to 4 mi., 1959.

This map is the third of a series adopted for use as a reference source in locating mineral occurrences in Maine and literature describing such occurrences. Shown on the map, which features towns, roads, streams, ponds, and topographic contours, are 95 occurrences of such resource types as granites, pegmatites (feldspar-quartz-mica-etc.), metals, diatomite, peat, and so forth. Each occurrence is keyed to an index which details sources of literature for said occurrence. The map covers approximately 3,500 sq. mi. in southwestern Maine from Brownfield to Kittery on the W. and Kittery to Tenants Harbor along the coast, at a scale of 1 in. to about 4 mi. --Maine Geol. Survey.

1-2160. Moore, George E., Jr. CAROLINA AND QUONOCHONTAUG, RHODE ISLAND. BEDROCK GEOLOGY: U. S. Geol. Survey, Geol. Quad. Map GQ-117, scale 1:31,680, contour interval 10 ft., lat. 41°19'18"-41°30'N. long. 71°37'30"-71°45'W., 1959.

Correction of title and latitude coordinates published in GeoScience Abstracts 1-1609.

1-2161. Mapel, W. J., C. S. Robinson, and Paul K. Theobald, Jr. GEOLOGIC AND STRUCTURE CONTOUR MAP OF THE NORTHERN AND WESTERN FLANKS OF THE BLACK HILLS, WYOMING, MONTANA, AND SOUTH DAKOTA: U. S. Geol. Survey, Oil & Gas Inv. Map OM-191, 2 sheets, scale 1:96,000, 1959.

Information that will be useful in the continuing search for fuel resources and mineral deposits is presented for an area of about 4,000 sq. mi. The map shows structure contours drawn on the Fall River sandstone [Lower Cretaceous], localities where coal and U are mined, and oil-producing areas. A list of selected wells drilled prior to Feb. 1956 and an isometric diagram showing relations of marine Cretaceous rocks accompany the map. Well sites are approximately located. --U. S. Geol. Survey.

1-2162. Mapel, W. J., and G. B. Gott. DIAGRAMMATIC RESTORED SECTION OF THE INYAN KARA GROUP, MORRISON FORMATION, AND UNKPAPA SANDSTONE ON THE WESTERN SIDE OF THE BLACK HILLS, WYOMING AND SOUTH DAKOTA: U. S. Geol. Survey, Mineral Inv. Map MF-218, scale 1:253,440, 1959.

Lithologic units in the nonmarine Inyan Kara group [Lower Cretaceous], Morrison formation and Unkpapa sandstone [Upper Jurassic] have been correlated along the W. side of the Black Hills for a distance of about 140 mi. The correlations and the stratigraphic positions of U deposits in different areas are illustrated. --U. S. Geol. Survey.

1-2163. Brown, Glen F., and Roy O. Jackson. GEOGRAPHIC MAP OF THE NORTHEASTERN HIJAZ QUADRANGLE, KINGDOM OF SAUDI ARABIA: U. S. Geol. Survey, Misc. Inv. Map I-205 B, scale 1:500,000, lat. 24°-28°N. 39°-42°E., 1959.

PART 2. AREAL AND REGIONAL GEOLOGY

See also: Structural Geology 1-2231; Igneous and Metamorphic Petrology 1-2356.

1-2164. Gaucher, Edwin H. PRELIMINARY REPORT ON THE SOUTHEAST QUARTER OF ROY TOWNSHIP, ABITIBI-EAST ELECTORAL DISTRICT: Quebec, Dept. Mines, Prelim. Rept. no. 379, 12 p., fold. geol. map (Prelim. Map no. 1255) scale 1:12,000, 1959, 4 refs.

The 25-sq. mi. area, mapped in summer 1957, lies 10 mi. E. of Chibougamau. All consolidated rocks are Precambrian. Oldest rocks are Keewatin-type basalts, andesites, and pyroclastic rocks metamorphosed into greenstones. These volcanic rocks of the northern part of the area are intruded by thick sills of rocks belonging to the ultrabasic complex. S. of the volcanic formations, the bedrock consists of anorthosite. In the SE. corner of the map-area, a granitic mass cuts the anorthosite. All the rocks, especially the anorthosite, have been intruded by a number of small dikes of various compositions. Youngest rock of the area is a large dike of diorite-gabbro which cuts diagonally across the map-area in a NE. direction. The volcanic and pyroclastic formations have a general trend carying from E.-W. to N. 70°E., and the dips are steep or vertical. Indications of numerous faults and shear zones were found. The presence of Cu, Ag, Au, Zn, Fe, and asbestos was noted. Results of concentration tests on samples from an important Fe-bearing formation are included. --A. C. Sangree.

1-2165. Imbault, P. E. QUEYLUS AREA, ABITIBI-EAST AND ROBERVAL ELECTORAL DISTRICTS: Quebec, Dept. Mines, Geol. Rept. 83, 37 p., 10 illus. on 4 pls., geol. map (in pocket), scale 1:63,360, 1959, 15 refs.

The 193-sq. mi. area (49°30'-49°45'N. 74°15-74°30'W.), part of the Chibougamau region, was mapped in 1950. All consolidated rocks are Precambrian and constitute 2 main groups of about equal extent. The older group is largely volcanic and possibly Keewatin in age. It consists of basaltic and andesitic lavas, with minor quantities of pyroclastics, sedimentary rocks, and diorite and gabbro sills. The younger (intrusive) group includes gabbro-anorthosite, granite, and biotite granite. The Dauversière granite is intruded by several basic dikes that may be late Precambrian (Keweenawan?). Sand and gravel constitute the bulk of the Pleistocene deposits. Glacial erratics are common in the ground moraine. The Keewatin-like formations trend generally E.-W. Shear zones parallel to the schistosity or the gneissic structure of the rocks are numerous. Faults transverse to the structure of the rocks all strike northeasterly. Mineralization consists of disseminated sulfides in quartz and silicified schists and is associated with shearing. To 1950, 4 companies had partly explored 5 showings from all of which Au values were reported. The properties are described. --A. C. Sangree.

1-2166. McGerrigle, J. I. PRELIMINARY REPORT ON ST. HIPPOLYTE AREA, ELECTORAL DISTRICTS OF TERREBONNE AND MONTCALM: Quebec, Dept. Mines, Prelim. Rept. no. 393, 10 p., fold. geol. map (Prelim. Map no. 1280) scale 1:12,000, table, 1959.

This 25-sq. mi. area (45°55'-46°N. 74°-74°05'W.), 40 mi. NW. of Montreal, was mapped in summer 1958. All consolidated rocks are Precambrian. Rocks of the Grenville series are represented by only 2 exposures of quartzite and some inclusions of quartzite and possibly of paragneiss. More than 95% of the exposed bedrock belongs to an intrusive series which ranges from anorthosite to gabbro, the former being predominant. Some quartz monzonite, pegmatitic and mylonitic rocks are present, and several diabase dikes cut the older formations. Pleistocene and Recent sand, gravel, and morainic material cover about two-fifths of the map-area. Angular boulders are quite common. Structure is relatively simple as the area lies entirely within the Morin anorthosite massif. A gneissic structure is quite prominent in some of the anorthosite. Joints are very common, being especially well-developed in the anorthositic rocks. Main mineral deposits are those of titaniferous Fe. Three parts of the area were covered by dip needle surveys. Seven samples were analyzed for Fe and titanium dioxide, and results are tabulated. Three mining properties are described. --A. C. Sangree.

1-2167. Neale, E. R. W. DOLLIER-CHARRON AREA, ABITIBI-EAST AND ROBERVAL ELECTORAL DISTRICTS: Quebec, Dept. Mines, Geol. Rept. 82, 46 p., 8 illus., geol. map (in pocket) scale 1:63,360, 1959, 29 refs.

Mapping of this 200-sq. mi. area (49°30'-49°45'N. 74°-74°15'W.) was carried out in 1953. All bedrock is Precambrian. Two major rock groups are recognized: 1) metamorphosed volcanic and sedimentary rocks, 2) younger intrusive rocks, including some composite (or mixed) gneisses. "Keewatin- and Timiskaming-type" volcanic and sedimentary rocks of low metamorphic grade crop out as a broad NE.-trending band in the northwestern part of the area. Eastward they grade into garnetiferous schists and gneisses. In the SE. the gneisses resemble the "Grenville-type." They include orthogneisses and composite gneisses. Anorthositic and granitic rocks in the extreme NW. corner of the area are part of the southeastern border zone of a large intrusive complex underlying the Chibougamau Lake region. Gabbro dikes cutting the southeastern gneisses are the youngest intrusive rocks of the area. Pleistocene deposits include drumlins and ground moraine, eskers, kames, and lake sediments. The map-area lies across a segment of the boundary between the Superior (Timiskaming) and Grenville provinces of the Canadian Shield. The chief characteristics of the boundary in this area are apparently due to igneous intrusion and synchronous directed forces from the E. or SE. which caused the increase in metamorphic grade and the abrupt change in structural trend that mark the boundary zone. Structural features are described. The "Timiskaming- and Keewatin-type" greenschists and the intrusive rocks of the Chibougamau complex offer most promise to prospectors. --A. C. Sangree.

1-2168. Anderson, Roger Y., and John W. Harshbarger, eds. GUIDEBOOK OF THE BLACK MESA BASIN, NORTHEASTERN ARIZONA. NINTH FIELD CONFERENCE, OCTOBER 16, 17, AND 18, 1958: 205 p., illus., geol. maps, secs. (1 in pocket), diags. (2 in pocket), [Socorro, New Mexico], New Mexico Geological Society, in cooperation with the Arizona Geological Society, 1958, refs.

This field conference was the first major excursion into the Black Mesa basin. In addition to road logs, the volume contains 28 papers dealing with a wide range of subjects in northern Arizona and New Mexico.

Contents are listed below. Titles indicated in capital letters are separately abstracted in the order in which each paper appears in the guidebook.

Road Logs

Beaumont, Edward C., J. P. Akers, and Neal E. McClymonds. Road log from Gallup to Holbrook via St. Michaels, Lupton, and Petrified Forest

Read, Charles B., and Philip T. Hayes. Panel discussion of Bernal-Whitehorse-Chalk Bluff nomenclatorial problem, p. 204.

Silver, Caswell. Evolution of petroleum exploration in the San Juan basin, p. 204.

Speed, Bert L. A sedimentary study of the Yeso formation of central and northern New Mexico, p. 204.

Totten, Robert B. Subsurface geology and economic aspects of the Morrow series, western Anadarko basin, Texas and Oklahoma Panhandle area, p. 205.

Weir, James E., Jr. Geology and hydrology of the Valles caldera, Sandoval County, New Mexico, p. 205.

1-2169. Lance, John F. PRECAMBRIAN ROCKS OF NORTHERN ARIZONA (In: Anderson, Roger Y., and John W. Harshbarger, eds. Guidebook of the Black Mesa Basin, Northeastern Arizona...: p. 66-70, [Socorro, New Mexico], New Mexico Geological Society, 1958) 21 refs.

This brief but comprehensive résumé reviews the pertinent published data on Precambrian rocks throughout most of Arizona. The publicized Precambrian of the Grand Canyon area consists of the Archean Vishnu schist (metamorphosed clastic sediments and metavolcanics) intruded by granitic masses, planed beneath an Ep-Archean erosion surface, and overlain by the Algonkian Grand Canyon series, a lower Unkar group of clastic rocks and limestone, and the upper Chuar group. Block faulting and cutting of an Ep-Algonkian erosion surface preceded Cambrian sedimentation.

In central Arizona similar Precambrian rocks and events are recorded by the Archean Yavapai schist and associated granitic bodies, truncated beneath the Algonkian Apache group.

The Precambrian of the Defiance uplift, referred to the Archean, includes quartzite, granite, and, here described for the first time, metasediments and metavolcanics, all overlain by the Supai (Permian?) red beds. --F. E. Kottlowski.

1-2170. Turner, Daniel S. DEVONIAN SYSTEM OF THE BLACK MESA BASIN (In: Anderson, Roger Y., and John W. Harshbarger, eds. Guidebook of the Black Mesa Basin, Northeastern Arizona...: p. 71-73, [Socorro, New Mexico], New Mexico Geological Society, 1958) 11 refs.

Shows of oil and gas in Devonian rocks occur in outcrops and have been noted in oil tests on the N., S., and W. sides of the Black Mesa basin [NE. Arizona].

The Elbert formation, an upper dolomite and the lower McCracken sandstone member, may extend from Utah southward into the northeastern quarter of the basin. The Martin limestone of the Mogollon Rim projects into the southern part of the basin, and from the W. the Temple Butte limestone (and sandstone) of the Grand Canyon may be a correlative of the Elbert formation. The pre-Elbert Aneth formation may project southward from the Paradox basin.

Sample studies suggest the Oraibi trough, W. of the Defiance uplift and connected to the Paradox basin by the Chinle straits, received a considerable amount of marine and shallow marine sediments during Devonian time when the trough roughly coincided with most of the present Black Mesa basin. --F. E. Kottlowski.

1-2171. McKee, Edwin D. THE REDWALL LIMESTONE (In: Anderson, Roger Y., and John W. Harshbarger, eds. Guidebook of the Black Mesa Basin, Northeastern Arizona...: p. 74-77, map, columnar sec., [Socorro, New Mexico], New Mexico Geological Society, 1958) 8 refs.

The Redwall limestone of Mississippian age extends across a major part of northern Arizona with remarkably little lithologic variation. It changes in thickness from more than 900 ft. in the northwestern corner of the state to less than 350 in the northeastern corner, and appears to lap against the ancient Defiance uplift farther SE. Four vertical subdivisions or members are recognized virtually throughout this region. A change from thick to thin bedding between the lower 2 members and a similar change between the upper 2 probably result from original changes in base level and in each case appear to have terminated with general beveling of the surface. The suggestion is made that the thick beds were formed during times of transgression and the overlying thin beds represent deposits of regression. Sedimentation appears to have been on a shelf area with a geosyncline to the NW. The many varieties of limestone and dolomite deposited were mostly clastic or bioclastic. No beds of sandstone, mudstone, or gypsum are reported in the Redwall limestone of this area and noncarbonate minerals other than chert are rare in the limestone. Bedded cherts, widespread at some horizons, are a consistent feature, interpreted as the result of early diagenetic processes operating on the seafloor. --Auth.

1-2172. Havenor, Kay, and Willard D. Pye. PENNSYLVANIAN PALEOGEOGRAPHY OF ARIZONA (In: Anderson, Roger Y., and John W. Harshbarger, eds. Guidebook of the Black Mesa Basin, Northeastern Arizona...: p. 78-81, 4 figs., [Socorro, New Mexico], New Mexico Geological Society, 1958) 9 refs.

The present distribution and lithology of the Pennsylvanian and subjacent rocks indicates that during latest Mississippian and earliest Pennsylvanian time nearly all of Arizona was a positive area which had been epeirogenetically uplifted during Late Mississippian time. Throughout wide areas of Arizona a regolith and karst topography developed on the exposed Mississippian limestones.

No rocks of Morrowan age are known in Arizona. By Des Moinesian time a major part of eastern and southern Arizona was completely inundated by seas from the Cordilleran and Sonoran geosynclines. During Virgilian time the seas reached their maximum extent, covering all of Arizona except the Defiance uplift which was a positive feature throughout Pennsylvanian time.

The Paradox basin was a strongly subsiding structural feature during Des Moinesian time. This basin shelved towards the Defiance uplift on the S. and toward the positive northwestern portion of Arizona to the SW. of the basin.

The oldest marine Pennsylvanian rocks known in Arizona are in the southeastern part of the state. Southern Arizona was a mildly negative area in which thick marine sediments accumulated continuously from at least Atokan into Permian time. The major basin of Pennsylvanian and Permian sedimentation with southeastern Arizona follows a major structural trend which crosses southern Arizona into southwestern New Mexico. From the age, lithology, and distribution of the Pennsylvanian rocks in this area

of deposition it is concluded that the original extent of Pennsylvanian rocks in southern and western Arizona was considerably greater than at present. --K. C. Havenor.

1-2173. Peirce, H. Wesley. PERMIAN SEDIMENTARY ROCKS OF THE BLACK MESA BASIN AREA (In: Anderson, Roger Y., and John W. Harshbarger, eds. Guidebook of the Black Mesa Basin, Northeastern Arizona...: p. 82-87, 4 maps, diag., [Socorro, New Mexico], New Mexico Geological Society, 1958) 16 refs.

Data of the Permian rocks are from a few drill holes and projected from outcrops fringing the Black Mesa basin. The Pennsylvanian-Permian boundary is within the lower Supai red beds whereas the upper contact of the Permian is with Triassic rocks.

The Supai formation, dominantly of reddish sandy clastic rocks, is thickest (2,600 ft.) near Holbrook where evaporites are prominent, and thins northward toward Kaibito and eastward toward Ft. Defiance. The Halgaito, Cedar Mesa, Organ Rock, and lower DeChelly members of the Cutler formation coalesce southward with the Supai.

Problems of correlating the Coconino-DeChelly-Glorieta sandstones are critical; thickness distribution of these sandstones shows thinning to the NW. and SE. from a suggested belt of maximum sandstone development that trends SW. from Chinle to Winslow and Pine.

The Kaibab-Toroweap formations, of limestone, sandstone, and siltstone, thicken to the NW. and pinch out eastward onto the Defiance uplift. Total thickness of the Permian is about 3,200 ft. SW. of Holbrook and only 1,200 ft. near Ft. Defiance. --F. E Kottlowski.

1-2174. Akers, J. P., Maurice E. Cooley, and Charles A. Repenning. MOENKOPI AND CHINLE FORMATIONS OF BLACK MESA AND ADJACENT AREAS (In: Anderson, Roger Y., and John W. Harshbarger, eds. Guidebook of the Black Mesa Basin, Northeastern Arizona...: p. 88-94, 4 figs. incl. map, diag., [Socorro, New Mexico], New Mexico Geological Society, 1958) 8 refs.

Study of the Moenkopi and Chinle formations is part of the ground-water investigation by the U. S. Geological Survey in the Navajo and Hopi Indian Reservations.

The unconformity at the base of the Moenkopi formation represents a period of erosion extending from late Permian to Early Triassic time. The period of erosion was shortest in the Lees Ferry area where the Lower and Middle(?) Triassic Moenkopi formation lies on the Kaibab limestone of Leonard age. A longer period of erosion is indicated in the vicinity of the Defiance uplift as the Moenkopi and Kaibab are absent and the Upper Triassic Chinle formation overlies the De Chelly sandstone.

In the western part of the area the Moenkopi is divided into 3 members: the basal Wupatki, the medial Moqui, and the upper Holbrook members. The Wupatki and Moqui members thin to the SE. and are not recognized in the area E. and SE. of Holbrook near the Lupton and Hunt.

Because the Moenkopi formation may contain beds as young as Middle(?) Triassic, the hiatus represented by the unconformity between the Moenkopi and Chinle formations may be shorter than was formerly supposed.

Five members are recognized in the Chinle formation. The basal Shinarump member is present in the entire area except locally in the Little Colorado River Valley. The lower red member, Gregory's "Division D," is present only in the eastern part of the Navajo Indian Reservation. The Mesa Redondo member occupies a stratigraphic position equivalent to the lower red member and is present only in the Hunt-St. Johns area. The Petrified Forest member is subdivided in the eastern and southeastern part of Black Mesa basin into upper and lower parts by a prominent bed, or group of beds, herein named the Sonsela sandstone bed, from exposures near the Sonsela Buttes about 25 mi. N. of Fort Defiance, Arizona. The Sonsela sandstone bed is not present W. of a line paralleling and 30 mi. W. of the Arizona-New Mexico state line. The Owl Rock member, Gregory's "Division B," occurs in the entire Navajo reservation, but is not present S. of St. Johns or in the northern part of House Rock Valley. --J. P. Akers.

1-2175. Evensen, Charles G. THE SHINARUMP MEMBER OF THE CHINLE FORMATION (In: Anderson, Roger Y., and John W. Harshbarger, eds. Guidebook of the Black Mesa Basin, Northeastern Arizona...: p. 95-97, [Socorro, New Mexico], New Mexico Geological Society, 1958) 11 refs.

The Shinarump member of the Upper Triassic Chinle formation in the Black Mesa basin consists of about 50 ft. of sandstone and conglomerate, and rare mudstone. In most places it overlies the Moenkopi formation (Lower and Middle(?) Traissic) although locally it overlies the DeChelly sandstone (Permian). The Shinarump was deposited by braided stream systems whose constant reworking caused sheets of sand and gravel to advance across a relatively flat erosion surface, modified by the entrenchment of late Moenkopi streams and further modified by the Shinarump streams. This erosion cut channels into the Moenkopi sediments as much as 275 ft. in depth and in these channels the U deposits occur. A conspicuous zone of bleaching occurring in the upper Moenkopi was caused largely by ground-water action and modified locally by mineralizing solutions. The upper contact is gradational both laterally and vertically into the overlying Chinle member. Slightly arkosic sandstone comprises about 75% of the Shinarump in the Navajo country with cement of calcite and silica. Conglomerates consist of resistant siliceous pebbles probably derived from highlands to the S., and fragments of various sizes of Moenkopi and DeChelly lithology which do not appear to have been transported an appreciable distance. U deposits generally occur in scours along the channels, particularly in "trashy" sediments consisting of carbonaceous and argillaceous material in the sandstone and conglomerate. Clean sandstone is relatively unfavorable as a U host rock. --Auth.

1-2176. Harshbarger, John W., Charles A. Repenning, and James H. Irwin. STRATIGRAPHY OF THE UPPERMOST TRIASSIC AND THE JURASSIC ROCKS OF THE NAVAJO COUNTRY (In: Anderson, Roger Y., and John W. Harshbarger, eds. Guidebook of the Black Mesa Basin, Northeastern Arizona...: p. 98-114, 9 figs., 3 pls. (incl. 2 diags. in pocket), [Socorro, New Mexico], New Mexico Geological Society, 1958) 45 refs.

The Navajo country, mostly in northeastern Arizona and northwestern New Mexico with adjoining

parts of Utah and Colorado, includes the Black Mesa basin and western San Juan basin.

Uppermost Triassic and the Jurassic rocks are in the Glen Canyon group, San Rafael group, Cow Springs sandstone, and Morrison formation. Basal beds of the Glen Canyon group, conformable to unconformable on the Chinle formation, are in the Wingate sandstone with its lower silty Point Rock member and upper Lukachukai eolian sandstone member. Above, in the western Navajo country, is the Moenave formation, with a basal Dinosaur Canyon sandstone member, and upper Springdale sandstone member. Next in ascending order is the Kayenta formation with a northern sandstone facies and a southwestern silty facies. The prominent, eolian Navajo sandstone forms the top unit of the Glen Canyon group.

The San Rafael group, erosionally unconformable on the Navajo, Kayenta, or Wingate sandstones, includes in ascending order, the silty Carmel formation, Entrada sandstone, Todilto limestone, Summerville formation, and Bluff sandstone.

The crossbedded Cow Springs sandstone intertongues with the Summerville, Bluff, and Morrison formations as northward thinning tongues. The Morrison, consisting of interfingering fluviatile beds, includes 4 members, the basal Salt Wash, Recapture, Westwater Canyon, and upper Brushy Basin. In most of the Navajo country the Dakota sandstone rests erosionally unconformably on the Jurassic rocks. --F. E. Kottlowski.

1-2177. Page, Harry G., and Charles A. Repenning. LATE CRETACEOUS STRATIGRAPHY OF BLACK MESA, NAVAJO AND HOPI RESERVATIONS, ARIZONA (In: Anderson, Roger Y., and John W. Harshbarger, eds. Guidebook of the Black Mesa Basin, Northeastern Arizona...: p. 115-122, 3 figs., [Socorro, New Mexico], New Mexico Geological Society, 1958) 21 refs.

Late Cretaceous rocks are erosionally unconformable on progressively older strata from NE. to SW. in the Black Mesa area, and locally underlie the Pliocene Bidohochi formation. At the base, the Dakota sandstone is divisible into a lower sandstone, a middle carbonaceous unit, and an upper sandstone. The overlying Mancos shale intertongues with its adjacent sandstones and pinches out southwestward near Showlow; the shale is of Greenhorn and Carlile age on Black Mesa.

The overlying Mesaverde group consists of the basal Toreva formation, the Wepo formation, and the upper Yale Point sandstone. Sandstones of the Toreva formation appear correlative with the Gallup sandstone in the San Juan basin of New Mexico, the Wepo formation correlative with the Crevasse Canyon formation, and the Yale Point sandstone appears traceable eastward into the Hosta tongue of the Point Lookout sandstone. --F. E. Kottlowski.

1-2178. Repenning, Charles A., John F. Lance, and James H. Irwin. TERTIARY STRATIGRAPHY OF THE NAVAJO COUNTRY (In: Anderson, Roger Y., and John W. Harshbarger, eds. Guidebook of the Black Mesa Basin, Northeastern Arizona...: p. 123-129, 4 figs. incl. geol. map scale 1:970,000, [Socorro, New Mexico], New Mexico Geological Society, 1958) 14 refs.

The Chuska sandstone and Bidahochi formation were deposited on erosion surfaces; the pre-Chuska surface is at an elevation of about 8,000 ft., the Zuni surface (pre-Bidahochi) at 6,000-7,200 ft.

The Chuska sandstone, occurring chiefly in the Chuska Mountains of New Mexico and Arizona, is of Pliocene(?) age, is as much as 1,800 ft. thick, and consists of lower fluvial sandstones and bentonitic clays, and upper eolian sandstones. Crossbedding suggests southerly flowing streams or winds from the W. and SW.

The Pliocene Bidahochi formation includes: 1) a lower lacustrine member of banded mudstones, argillaceous sandstones, and tuff-bentonite beds, totaling 214 ft. thick, 2) a volcanic member, 2-50 ft. thick, of basaltic flows, tuff, volcanic conglomerates, and travertine, and 3) an upper fluvial member, up to 450 ft. thick, of sandstone and rhyolitic ash.

Two Pliocene rivers are postulated; the southwesterly flowing ancestral Rio Puerco, and the northwesterly flowing ancestral Carrizo Wash, both emptying into the Pliocene Bidahochi lake basin. --F. E. Kottlowski.

1-2179. Kelley, Vincent C. TECTONICS OF THE BLACK MESA BASIN REGION OF ARIZONA (In: Anderson, Roger Y., and John W. Harshbarger, eds. Guidebook of the Black Mesa Basin, Northeastern Arizona...: p. 136-144, 4 figs., [Socorro, New Mexico], New Mexico Geological Society, 1958) 27 refs.

The region of northeastern Arizona embracing the Black Mesa basin covers about 10,000 sq. mi. and includes much of the southwestern part of the Colorado Plateau. The Black Mesa basin proper is bordered on the E. by the Defiance uplift, on the N. by the Tyende saddle, southern end of the Monument uplift, Oljeto sag, Piute fold belt, and Kaibito saddle, on the W. by Preston and Cameron benches, and on the S. by the Wupatki bench and Mogollon slope. The general nature and principal parts of these surrounding elements are described and their relationship to the restricted basin is explained. An index map showing the tectonic elements (scale 1 in. to 10 mi.) and aerial mosaics of the pronounced adjacent Organ Rock and Coconino uplifts are the principal illustrations.

The paper concludes with an analysis of the tectonic history and origin. General stability modified by mild epeirogenies at or near sea level characterized the Paleozoic. During Triassic and early Jurassic the region subsided several thousand feet. During late Jurassic and early Cretaceous the southern part of the region was first tilted northward and then in late Cretaceous depressed several thousand feet. The principal modern structures were produced during Laramide time with the Black Mesa basin being a part of a northwesterly trending sag that extends across the southwestern part of the Colorado Plateau from S. of the Zuni uplift in New Mexico through the Black Mesa and Kaiparowits basins to the High Plateaus of Utah. --Auth.

1-2180. Doeringsfeld, Walter W., Curtis L. Amuedo, and John B. Ivey. GENERALIZED TECTONIC MAP OF THE BLACK MESA BASIN (In: Anderson, Roger Y., and John W. Harshbarger, eds. Guidebook of the Black Mesa Basin, Northeastern Arizona...: p. 145, scale 1:1,277,200, [Socorro, New Mexico], New Mexico Geological Society, 1958).

The generalized tectonic map of the Black Mesa basin at the scale 1:1,277,200 (1 in. to 20 mi.) includes approximately 21,000 sq. mi. in Coconino,

Navajo, and Apache counties, Arizona. The map is a compilation of published material and is designed to show the spatial relationships of major structural features. Major drainage, towns of importance, and township and range designations are indicated. Geologic features shown include major anticlines, synclines, monoclines, and faults; the outcrop of the base of the Cretaceous in the basin; and the outcrop of Tertiary intrusive and extrusive rocks, and of Quaternary and Tertiary volcanic rocks. In cases where geologic features have been named, the names appear on the face of the map. --J. B. Ivey.

1-2181. Cooley, Maurice E. PHYSIOGRAPHY OF THE BLACK MESA BASIN AREA, ARIZONA (In: Anderson, Roger Y., and John W. Harshbarger, eds. Guidebook of the Black Mesa Basin, Northeastern Arizona...: p. 146-149, map, 2 secs., table, [Socorro, New Mexico], New Mexico Geological Society, 1958) 7 refs.

The Black Mesa basin area is part of a broad structural trough which includes the Kaiparowits basin to the NW. and a shallow basin near St. Johns to the SE. It is bounded on the E. by the Defiance uplift, on the NE. by the Monument upwarp, on the NW. by the Kaibab uplift, and on the SW. by the broad Mogollon slope. The basin area contains 2 types of major physiographic landforms: 1) mesas (center of Black Mesa basin) and plateaus (Defiance and Kaibab uplifts), and 2) large subsequent valleys adjoining Black Mesa which are occupied by the Little Colorado River and Chinle Wash. Physiographically the basin area lies between the canyon lands adjacent to the Colorado and San Juan rivers, and the plains and broad mesas of the Datil section. It comprises primarily the Black Mesa, Painted Desert, and Chinle Valley subdivisions, and includes part of the eastern Grand Canyon, Navajo uplands, Monument Valley, Defiance uplift, and Mogollon slope. The Black Mesa, Painted Desert, Chinle Valley, and Defiance uplift subdivisions are described in this paper.

The following erosion surfaces are recognized and briefly discussed: Tsaile, Hopi Buttes, Zuni, Black Point, and Wupatki. "The erosion surfaces of the Little Colorado River system can be traced throughout the Black Mesa basin area from the Mogollon rim to the northern part of Black Mesa, and from the San Francisco plateau to the Zuni Mountains. In much of the peripheral area of the basin, lava flows overlie and protect the erosion surfaces. Their conspicuous topographic features aid considerably in the tracing and correlation of the several surfaces. The surfaces represent several stages of valley development by the through-flowing ancestral Little Colorado River which drained toward the W. and NW. and joined the Colorado River somewhere near the present junction." --A. C. Sangree.

1-2182. Sharp, Robert P. THE PLEISTOCENE GLACIATION OF SAN FRANCISCO MOUNTAIN, ARIZONA (In: Anderson, Roger Y., and John W. Harshbarger, eds. Guidebook of the Black Mesa Basin, Northeastern Arizona...: p. 150-152, 4 figs. incl. map, [Socorro, New Mexico], New Mexico Geological Society, 1958) 8 refs.

Evidence of 3 distinct glaciations, tentatively dated as later Wisconsin (Tioga), early Wisconsin (Tahoe), and Illinoian, consists of moraines, outwash deposits, till, striated bedrock surfaces, and cirques. The Pleistocene orographic snowline lay at an elevation between 11,000 and 11,300 ft., whereas at present there is no snowfield preserved during the summer even on the highest peak (12,794 ft.). The volcanic construction of San Francisco peak itself was not later than the Illinoian. Early Wisconsin outwash underlies basaltic flows of the 3rd volcanic stage, suggesting that the 3rd stage, and subsequent stages 4 and 5, are younger than early Wisconsin. --Auth. and F. E. Kottlowski.

1-2183. Brown, Silas C., and Robert E. Lauth. OIL AND GAS POTENTIALITIES OF NORTHERN ARIZONA (In: Anderson, Roger Y., and John W. Harshbarger, eds. Guidebook of the Black Mesa Basin, Northeastern Arizona...: p. 153-160, 9 figs. incl. 6 maps, [Socorro, New Mexico], New Mexico Geological Society, 1958) 20 refs.

This paper, with the accompanying exhibits, points out some of the stratigraphic and structural problems of northern Arizona and the 2 distinct basins, the Paradox basin and the Black Mesa basin. Only a relatively small part of the Paradox basin extends into Arizona, where to date oil and gas production has been confined. The widely scattered tests outside of the Paradox basin have had good oil and gas shows which indicate commercial potentials under proper conditions.

The Black Mesa basin is a structural depression which lies near the center of the Navajo Reservation and is bounded on the E. by the Defiance uplift, on the W. by the Kaibab Plateau, on the N. by the Monument uplift, and on the S. by the Mogollon Rim. The major folding, of Paleozoic age, has a NW. alignment. Secondary alignments have a NE. trend, a N.-S. trend, and a still weaker trend which parallels the edge of the basin. These secondary alignments are post-Paleozoic in age. The Paleozoic trends are considered the most favorable for commercial production.

The 2 cross-sections presented show generalized thickness of the formations from Precambrian to Tertiary, projected correlations, outcrops, topography, and general structural features. Isopach maps of the Cambrian, Devonian, Mississippian, Pennsylvanian, Permian, and Cretaceous are presented.

The largest oil and gas wells have been and shall probably continue to be found along the southern edge of the Paradox basin in its foreland facies zone. The Pennsylvanian formations have good potentials along the southern edge of the Black Mesa basin. Shows in wells, petroliferous indications in the outcrops, and regional thickening of the Mississippian, Devonian, and Cambrian indicate that potential producing reservoirs may be developed in rocks of these systems.

The Fort Apache member of the Supai, the De-Chelly member of the Cutler, and the Coconino sandstone have excellent potential for shallow production. --R. E. Lauth.

1-2184. Birdseye, Henry S. URANIUM DEPOSITS IN NORTHERN ARIZONA (In: Anderson, Roger Y., and John W. Harshbarger, eds. Guidebook of the Black Mesa Basin, Northeastern Arizona...: p. 161-162, map, [Socorro, New Mexico], New Mexico Geological Society, 1958) 7 refs.

U occurs as bedded deposits in Mesozoic sedimentary rocks and the ore is processed in mills at Tuba City and Durango. Reserves of 0.3% U_3O_8 were estimated at 2.6 million tons in Dec. 1957.

U in the Morrison formation occurs in the Salt Wash member of the Lukachukai-Chuska Mountains and Carrizo Mountains of Arizona and New Mexico. Ore is found in permeable sandstones associated with carbonized vegetal debris.

On the southern flank of the Monument upwarp, U ore occurs in basal channel-filling bodies of the Shinarump conglomerate, associated with carbonized plant matter and Cu minerals.

Along the S. rim of the Black Mesa basin, U ore is mined from sandy scour-filling mudstones of the Petrified Forest member of the Chinle formation.

The Carrizo Mountains deposits include a V-bearing mica so that the U ore contains about 1-5% V_2O_5. Noncommercial U deposits are reported from basal arkosic sandstones of the Toreva formation on Black Mesa, and ore-grade specimens of Todilto limestone have been turned in by prospectors but the source outcrops have not been found. --F. E. Kottlowski.

1-2185. Bollin, E. M., and Paul F. Kerr. URANIUM MINERALIZATION NEAR CAMERON, ARIZONA (In: Anderson, Roger Y., and John W. Harshbarger, eds. Guidebook of the Black Mesa Basin, Northeastern Arizona...: p. 164-168, 6 figs., [Socorro, New Mexico], New Mexico Geological Society, 1958) 13 refs.

The uranium mining is concentrated in a curved belt about 2 mi. wide extending 6 mi. N. and 18 mi. SE. of Cameron in central northern Arizona. U ore is beneficiated at Tuba City, and is found mostly in arkosic sandstones of the lower part of the Chinle formation's Petrified Forest member; the sandstones filled channel scours cut in bentonitic claystones.

The district is outlined on the N. and E. by the Wingate Cliffs, Navajo Cliffs, and Ward Terrace, on the S. by the Black Point monocline, and on the W. by the Coconino salient.

Primary mineralization, associated with organic detritus and controlled by fracturing and faulting, consists of uraninite, minor coffinite, pyrite, marcasite, and Cu, Co, and Mn minerals. Oxidized ores, which form the bulk of the commercial deposits, were localized by permeability.

Ore bodies are oriented perpendicular to sedimentary trends but parallel to directions of major faults. U-bearing solutions are believed to have originated from hydrothermal sources related to local volcanism during Triassic time. Much of the primary U appears to have been precipitated in the Shinarump conglomeratic member and later redistributed by ground-water leaching into sandstones of the overlying Petrified Forest member. --F. E. Kottlowski.

1-2186. O'Sullivan, Robert B. SUMMARY OF COAL RESOURCES OF THE BLACK MESA COAL FIELD, ARIZONA (In: Anderson, Roger Y., and John W. Harshbarger, eds. Guidebook of the Black Mesa Basin, Northeastern Arizona...: p. 169-171, geol. map scale 1:824,000 [Socorro, New Mexico], New Mexico Geological Society, 1958) 8 refs.

Coal deposits of Black Mesa have been mined for at least 600 years. Mineable beds are in the Dakota sandstone and Mesaverde group. In the Dakota sandstone, coal beds in the middle shale member are 2-4 ft. thick but locally, as at the Tuba City mine and near Steamboat, the beds are as much as 7-9 ft. thick.

Coal of the Mesaverde group is in the middle carbonaceous member of the Toreva formation and in the upper part of the Wepo formation. The Toreva coal beds are 5-7 ft. thick, those of the Wepo formation 4 1/2-10 ft. thick.

The largest annual production has been 11,000 tons. The coal was used by the Hopi Indians in 1,300 A. D. or earlier, thus predating the general use of coal in Europe. The mineable coals range from ashy subbituminous to high volatile bituminous with reserves estimated at 2 million tons. --F. E. Kottlowski.

1-2187. Akers, J. P., and John W. Harshbarger. GROUND WATER IN BLACK MESA BASIN AND ADJACENT AREAS (In: Anderson, Roger Y., and John W. Harshbarger, eds. Guidebook of the Black Mesa Basin, Northeastern Arizona...: p. 172-183, 8 figs., [Socorro, New Mexico], New Mexico Geological Society, 1958) 7 refs.

Black Mesa basin and adjacent areas comprise 8 physiographic subdivisions, each having a distinct ground-water potential. Wells in the Mogollon slope subdivision produce 200-300 g. p. m. (gallons per minute) of water from Permian aquifers at depths from 200 to 1,600 ft. Quality is excellent except in the Hunt-St.Johns area where it is poor to fair. In the Painted Desert subdivision Triassic and Permian rocks are dry or contain very poor water. Essentially all potable water is obtained from springs at the base of Tertiary lava capping the Hopi Buttes or from dug wells in alluvium. Nearly all wells in the Navajo uplands produce small amounts of excellent water from the Navajo sandstone at depths from 200 to 1,400 ft. In the Tuba City area wells in the Navajo sandstone yield up to 200 g. p. m. Cretaceous aquifers in the Black Mesa yield 5 to 30 g. p. m. of fair to good water from depths of 200 to 1,000 ft. Two out of 4 wells drilled in Permian rocks in Monument Valley were dry. The producing wells yield about 15 g. p. m. of good water from 400 to 900 ft. Alluvium along some washes contains good water, but along others it is dry. In the Chinle Valley wells in Permian and Traissic aquifers produce 15-100 g. p. m. of fair to poor water from depths up to 2,000 ft. Alluvium along Chinle Wash yields 200 g. p. m. or more, from depths less than 225 ft. Permian aquifers in most of the Defiance uplift yield 10-20 g. p. m. of good water from 200 to 500 ft., but some wells along the southern part are dry. No wells have been drilled in the Carrizo-Chuska Mountains subdivision, but adequate water for stock and domestic use can be obtained from springs issuing from Tertiary lava and sandstone.

Ground water in the Black Mesa basin area is obtained from alluvium, lava material filling diatremes, and sandstones from Permian to Tertiary in age. Most aquifers contain large amounts of water under both water-table and artesian conditions, but the yield is small except where faulting and fracturing has increased the permeability. In a few areas adequate water for industry and limited irrigation is available. --J. P. Akers.

1-2188. West, Sam W. THE GALLUP SANDSTONE AS A FRESH-WATER AQUIFER (In: Anderson, Roger Y., and John W. Harshbarger, eds. Guidebook of the Black Mesa Basin, Northeastern Arizona...: p. 184-185, [Socorro, New Mexico], New Mexico Geological Society, 1958).

Whereas oil and gas are produced from the Gallup sandstone in much of the San Juan basin of northwestern New Mexico, fresh water is obtained from

the sandstone on the SW. flank of the basin, the growing city of Gallup being dependent upon wells drilled to the Gallup sandstone for its water supplies.

The Gallup sandstone, 250-350 ft. thick, consists of firmly cemented sandstones and thin to thick beds of shale. Wells yield 45-200 g. p. m. (gallons per minute) although locally the upper part of the Gallup sandstone has been dewatered by excessive withdrawals. Specific capacity is 0.5-0.6 g. p. m. per ft. Quality of the water is good (44-94 parts per million, p. p. m., hardness as $CaCO_3$), but becomes more highly mineralized with increasing distance from the outcrops (304 p. p. m. hardness as $CaCO_3$). Depth of wells ranges from 125 to more than 400 ft. in and near the city of Gallup; depths are related to location on the anticline in the center of the city, to the shallow syncline near outcrops of the Gallup sandstone E. of the city, or to the deep syncline to the W. --F. E. Kottlowski.

1-2189. Smiley, Terah L. THE GEOLOGY AND DATING OF SUNSET CRATER, FLAGSTAFF, ARIZONA (In: Anderson, Roger Y., and John W. Harshbarger, eds. Guidebook of the Black Mesa Basin, Northeastern Arizona...: p. 186-190, 4 figs., [Socorro, New Mexico], New Mexico Geological Society, 1958) 9 refs.

The eruption of Sunset Crater, probably in A. D. 1064-1065, buried numerous pithouses occupied by the people living in the area E. of the San Francisco peaks. In this semiarid area, the mulching effects of the ash was of significance to the "dry-land farmers" and numerous people moved in from adjacent territories, constructing their houses and villages on the ash.

Wood beams were collected and dated from buried houses and from post-eruption houses on the ash. One of the beams from a buried house dated at A. D. 1046; and some of the beams from houses on the ash dated at 1071, thus the time of eruption was bracketed. Studies of the ring chronologies specimens from a pueblo on the ash indicated that, in at least 8 trees which had lived through the time in question, a distinct nonclimatic influence caused a departure in their growth following the ring laid down in A. D. 1064. Studies conducted on the effects of the activity in 1943 connected with the eruption of Paricutin, W. of Mexico City, indicate that the abnormal type of growth in the 8 specimens from the Sunset Crater area could have been caused by mechanical injury to the trees and the disruption of the "normal" variable soil moisture pattern by the mulching effect of the ash. --Auth.

1-2190. Du Bois, Robert L. SOME GEOLOGIC FEATURES OF THE ST. MICHAELS AREA, ARIZONA (In: Anderson, Roger Y., and John W. Harshbarger, eds. Guidebook of the Black Mesa Basin, Northeastern Arizona...: p. 191-193, geol. map scale approx. 1:125,000, [Socorro, New Mexico], New Mexico Geological Society, 1958).

Late Paleozoic and Mesozoic sediments were mapped in an area about 100 mi. square located on the eastern flank of the Defiance uplift 25 mi. NW. of Gallup, New Mexico.

Precambrian rocks at the core of the Defiance uplift are exposed at 2 places as isolated, unrelated outcrops, at one locality consisting of granitoid rocks, and at the second of a series of slates, phyllites, and metavolcanics.

The Permian Supai formation rests unconformably upon the Precambrian and the contact is marked by a basal conglomerate. The Permian DeChelly sandstone overlies the Supai and is in turn locally overlain by the Triassic Moenkopi formation. The Triassic Chinle formation generally caps the DeChelly and conformable above is the Triassic Wingate.

Jurassic units are the Entrada, Cow Springs, and Morrison formations. Cretaceous units are the Dakota sandstone, Mancos shale, and lower formations of the Mesaverde group. Several Tertiary vogesitic igneous bodies are intrusive into Paleozoic and Mesozoic rocks. Bedded Quaternary alluvium rests unconformably upon Paleozoic and Mesozoic rocks.

The main structure is an E.-dipping N.-trending zone that has been termed a monocline. It is sinuous with subsidiary anticlines and synclines that increase in size northward. Their axes trend northwesterly and plunge to the SE. Locally the beds of the monocline are overturned about 10°. Associated with this sharp flexure is a high angle N.-trending fault which to the S. is a northeasterly-trending normal fault with displacements exceeding 600 ft. --Auth.

1-2191. Phoenix, David A. SANDSTONE CYLINDERS AS POSSIBLE GUIDES TO PALEOMOVEMENT OF GROUND WATER (In: Anderson, Roger Y., and John W. Harshbarger, eds. Guidebook of the Black Mesa Basin, Northeastern Arizona...: p. 194-196, 3 figs., [Socorro, New Mexico], New Mexico Geological Society, 1958) 6 refs.

In southern Utah, near Lees Ferry, inclined sandstone cylinders transgress beds of siltstone and silty sandstone in the basal part of the Carmel formation of Jurassic age. Angular pebbles in the cylinders derived from beds at the base of the cylinders indicate that their formation was due to rupture by artesian pressure in the source bed for the pebbles. Because flow lines will be refracted at the interface between media of different permeability according to the ratio of the permeabilities, the direction of rupture should follow the flow lines and also be inclined. Thus the cylinders should be inclined in the same direction as the slope of the piezometric surface for the source bed. --Auth.

1-2192. Mudge, Melville R., and Robert H. Burton. GEOLOGY OF WABAUNSEE COUNTY, KANSAS: U. S. Geol. Survey, Bull. 1068, 210 p., 3 figs. incl. map, chart, 19 pls. (13 under separate cover) incl. illus., maps (geol. map scale 1 in. to 1 mi.), secs., diags., 2 tables, July 1959, 88 refs.

Wabaunsee County is in E.-central Kansas. The northern part of the county is mostly a till plain with smooth rounded hills; the eastern part is a relatively broad flat lowland with well-incised streams with shallow valleys, which is bordered on the W. by the Flint Hills escarpment. The central and western parts of the county comprise an upland that is part of the Flint Hills. The county is thoroughly drained by streams that have cut deep valleys that form a dendritic pattern.

The county is underlain by the Forest City structural basin, except the western part which contains the Nemaha and Alma anticlines. The oldest rocks exposed are of the upper part of the Pennsylvanian system. They generally consist of thin dark-colored fossiliferous limestone beds separated by relatively thick nonfossiliferous gray to olive-drab shale beds. Most of these shale beds contain sandy shale, sandstone, and beds of coal.

Two of the shales, the Plumb and Pony Creek shale members of the Wood Siding formation, contain deep ancient stream channels.

The lowermost 100 ft. of the Permian rocks are similar in lithology to the Pennsylvanian rocks. The Indian Cave sandstone bed of the Towle shale, a channel deposit, is exposed in 2 places in the county. The rest of the exposed Permian strata consist of thick light-colored limestone beds separated by thick brightly variegated and gray shale beds. Many of the gray shale beds are very fossiliferous. Biostromes were traced for a considerable distance in 3 of the Permian limestone beds.

Many exposures of the Permian and Pennsylvanian rocks were measured and studied in detail. Most of the units persist across the county, but they vary considerably in thickness and in character. The fauna of each unit was recorded, and some of the fossils were very important in the identification of certain limestones. Faunal changes were noted laterally in some of the beds of limestone and shale.

Sediments of Quaternary age are widespread, and chert gravels of pre-Kansan age are along many of the larger streams. In the northern part of the county the chert gravel deposits mark the position of Mill Creek before the advance of the Kansan ice sheet. The deposits indicate that this creek formerly extended northeastward from Alma to St. Marys.

At its maximum advance the Kansan glacier diverted the Kansas River southeastward through a series of cross-axial diversion channels and into Wakarusa Creek. As the ice retreated, the present course of the Kansas River and Mill Creek were established. Deposits of upper Kansan, Illinoian, and Wisconsin glacial stages also are in the county.

Limestone and gravel have been extensively used in the county as aggregate for concrete, and for road metal, ballast, and for various bituminous mixes; Permian limestone has been widely used also as structural stone. The limestone units quarried most are the Fort Riley, Threemile, Funston, Cottonwood, Neva, Red Eagle, Americus, Five Point, and Aspinwall units of the Permian system and Tarkio unit of the Pennsylvanian system.

The samples of limestones tested and accepted for concrete aggregate by the Kansas State Highway Commission were from the Funston, Threemile, part of the Neva, Cottonwood units, and from the biostrome in the Bennett shale member of the Red Eagle limestone. The limestone units acceptable as riprap and wash check are the Cottonwood, Eiss, Funston, Five Point, Fort Riley, Red Eagle, Neva, and Tarkio. The limestone units used in the county as structural stone are the Fort Riley, Crouse, Cottonwood, Neva, Five Point, Aspinwall, and Grayhorse.

Other information that may be of value to engineering, pertains to the use of shales and to the location of some seeps and springs. Many of the Permian and Pennsylvanian shales have been used as fill material along major highways. Small seeps and springs are at various horizons throughout the stratigraphic column. These are numerous within or at the base of Quaternary sediments, and in the Fort Riley, Florence, Threemile, Cottonwood, and Neva units. A few springs and seeps also occur in other beds of limestone and in beds of shale.

In Wabaunsee County, the Kansas River valley contains the largest potential reserves of sand and gravel acceptable for general engineering use. In the northern part of the county, chert gravels of pre-Kansan age have been used extensively for road metal on secondary routes. Other chert gravels, terrace deposits, and ordinary stream gravels along most of the major streams and their tributaries constitute a limited potential reserve of gravel for road metal. --Auth.

1-2193. Boucot, Arthur J., Charles Harper, and Keith Rhea. GEOLOGY OF THE BECK POND AREA - TOWNSHIP 3, RANGE 5, SOMERSET COUNTY, MAINE: Maine Geol. Survey, Spec. Geol. Studies Ser., no. 1, 33 p., 6 figs., geol. map, table, Jan. 1959.

This booklet describes the geology of a 160-acre area to the E. of King and Bartlett Lake, W.-central Somerset County. The report deals primarily with age and lithology of Lower Devonian limestone and limestone conglomerate which underlies slate of the Seboomook formation. Data are presented to indicate percentage of insolubles in certain limestone members. --R. G. Doyle .

1-2194. Boucot, Arthur J., John R. Griffin, George H. Denton, and Philip S. Perry. THE GEOLOGY OF A SIX-MILE SECTION ALONG SPENCER STREAM, SOMERSET COUNTY, MAINE: Maine Geol. Survey, Spec. Geol. Studies Ser. no. 2, 28 p., 9 figs., fold. geol. map and secs., table, May 1959.

This booklet describes the geology of a 6-mi. section of Spencer Stream from Spencer Dam to Spencer Gut in T 4, R 5, and T 3, R 5 in western Somerset County. The report deals primarily with the structure and stratigraphy of a section extending across the southeastern margin of the Moose River synclinorium which contains rocks of Siluro-Devonian age and into the underlying pre-Silurian rocks including the relationships of the intrusives. Data are presented showing the distribution and intensity of jointing and cleavage. Included with the text are 7 hemisphere equal-area projection nets, for graphic representation of jointing and cleavage lines. --R. G. Doyle.

1-2195. Wing, Lawrence A. AN AEROMAGNETIC AND GEOLOGIC RECONNAISSANCE SURVEY OF PORTIONS OF PENOBSCOT, PISCATAQUIS, AND AROOSTOOK COUNTIES, MAINE: Maine Geol. Survey, GP&G Survey no. 4, 18 p., 2 maps, profiles, Aug. 1959.

This survey includes 35 parallel flight lines, averaging 22 mi. in length and spaced at 1-mi. intervals, with fill-in lines to detail anomalous areas. Geologic mapping includes compilation of data from various unpublished sources, in addition to reconnaissance mapping and photogeologic interpretation on the ground. Survey results are presented in booklet form including descriptive text, base map, magnetic plan and profiles, geologic map and aerial photo index, reduced from a permanent file base of 1 in. to 1 mi. --R. G. Doyle.

1-2196. Wing, Lawrence A. AN AEROMAGNETIC AND RECONNAISSANCE SURVEY OF THE SIDNEY-AUGUSTA AND GARDINER AREAS, KENNEBEC COUNTY, MAINE: Maine Geol. Survey, GP&G Survey no. 5, 14 p., 5 maps incl. 3 geol., magnetic plans, profiles, Aug. 1959.

This survey includes 2 areas totaling about 46 sq.

mi. flown with 45 flight lines spaced at 1/4 mi. intervals. Geologic data include information from published and unpublished sources, plus reconnaissance mapping. Both areas are presented in a single booklet including base maps, magnetic plans and profiles, geologic maps and aerial photo indexes, reproduced from a permanent file base of 1 in. to 1 mi. --R. G. Doyle.

1-2197. Page, Ben M. GEOLOGY OF THE CANDELARIA MINING DISTRICT, MINERAL COUNTY, NEVADA: Nevada Bur. Mines, Bull. 56, 67 p., illus., geol. map scale 1:48,000, 1959, 29 refs.

The Candelaria district of western Nevada produced an estimated $15,000,000 to $20,000,000, principally from oxidized Ag ore mined in the 1870's and 1880's. The oldest rocks of the district are chert and dolomite of the Palmetto formation (Ordovician) unconformably overlain by the Diablo formation (Permian), a thin grit bed. The next sedimentary rock, the lower beds of which contain most of the mineral deposits, is shale of the Candelaria formation (lower Triassic). A serpentine mass and a variety of dikes cut the sedimentary beds.

Two major pre-Tertiary orogenies are clearly indicated. The earlier of the two, post-Ordovician to pre-middle Permian in age, produced tightly compressed folds and numerous fractures in the Palmetto formation before the deposition of the Diablo formation. The second major orogeny, Jurassic(?) in age, affected the Diablo and Candelaria formations which are steeply inclined and are displaced by faults.

Mineralization ensued after most of the Jurassic(?) folding and faulting was completed, but was probably related to later stages of the orogeny. After the formation of the ore deposits and an erosion interval, Tertiary volcanic outbursts blanketed the area with at least 2,000 ft. of pyroclastic rocks and lava. Dacite and rhyolite rocks predominate, but contain 2 or 3 interbedded basalt flows.

Gentle folding and extensive normal faulting affected all pre-Quaternary rocks together with the mineral-bearing veins. After an erosion interval, thin flows of basalt spread over much of the area in the Pleistocene(?). Block faulting of "basin and range" type displaced the Quaternary basalt flows, further dislocated the ore deposits, and may have continued into the Recent epoch. The 2 principal faults trend ENE. and are old faults which were revived in the Quaternary period. --Auth.

1-2198. Fay, Robert O. GUIDE TO ROMAN NOSE STATE PARK, BLAINE COUNTY, OKLAHOMA: Oklahoma Geol. Survey, Guide Book 9, 31 p., 9 figs., 4 pls., Aug. 1959, 31 refs.

The history, geology, botany, zoology, and recreational facilities of Roman Nose State Park, are presented. The historical portion includes all of Blaine County.

The rocks of the park belong to the Permian system, Guadalupean series, El Reno group, comprising the Flowerpot shale, Blaine formation, and Dog Creek shale (ascending). The illustrations include a colored geologic map of the park, a columnar section, and photographs of the springs. --Auth.

1-2199. Willard, Bradford, Jacob Freedman, Dean B. McLaughlin, Louis C. Peltier, H. R. Gault, Joseph H. Goth, Henry B. Roberts, J. Donald Ryan, Edwin W. Tooker, and Edgar T. Wherry. GEOLOGY AND MINERAL RESOURCES OF BUCKS COUNTY, PENNSYLVANIA: Pennsylvania Geol. Survey, Bull. C9, 243 p., 30 figs., 24 pls. incl. geol. & topo. maps (under separate cover), 55 tables, Aug. 1959, 206 refs.

Bucks County lies in southeastern Pennsylvania N. of Philadelphia. It is approximately 20 mi. wide and 40 mi. long in a NW.-SE. trend.

The rocks at the surface in Bucks County are primarily Triassic in age. Rocks of Precambrian, early Paleozoic, Tertiary(?), and Pleistocene ages are found in smaller areas. Cretaceous clays are found in subsurface.

Almost every type of rock is present. Precambrian and early Paleozoic schists and gneisses occur in the southeastern portion of the county and in the hills along the northern border. Early granitic and ultrabasic rocks occur in limited areas within these metamorphic rocks. Small areas of early Paleozoic rocks, limestones and orthoquartzites for the most part, crop out in the northern tip of the county, the southern part of the Reading Prong, and in the central Buckingham area.

Rocks of Triassic age cover nearly three fourths of the county. Sandstones, arkoses, shales, argillites, and siliceous fanglomerates comprise the majority of rock types. Triassic diabase intrusives form conspicuous hills in the NW. Because of the problems involved and the vast amount of Triassic deposition in Bucks County, the greatest part of the work was done on beds of this age. Detailed mapping shows clearly the intertonguing relationships of the different facies of the Newark group. The author has mapped separately the 3 characteristic lithologies which he calls the Stockton, Lockatong, and Brunswick lithofacies. Evidence from this mapping enabled him to show that the Triassic sediments were deposited in an irregular-floored basin which is quite separate from the Connecticut basin. The basin was a pre-existing topographic feature which was deepened by faulting that began after the start of deposition and continued during it. The lithofacies were formed by penecontemporaneous deposition from traceable source areas both to the N. and S. Diabase bodies in northern Bucks County have been mapped and studied in detail. They are surrounded by aureoles of argillite and shale altered to hornfels which contain magnetite, quartz, micas, cordierite, calcite, and epidote. Although the Newark strata are in general poor in fossils, a complete study of Triassic life reveals the fossil representatives of 6 phyla of plants and 5 phyla of animals.

Overlying the early Paleozoic crystallines in the extreme southeastern portion of the county along the Delaware River are unconsolidated outwash deposits of Wisconsin and pre-Wisconsin age which make up a series of terraces.

Mineral resources produced in Bucks County include sand and gravel, crushed stone, building stone, ornamental and other dimension stone, lime, ocher, slag, clay and clay products, and silica refractories. There has been production in the past of Fe ore, flux rock, and cement. Occurrences of Pb and Zn, Cu, barite, and Au have been prospected. --K. C. Kennedy.

1-2200. Swingle, George D. GEOLOGY, MINERAL RESOURCES, AND GROUND WATER OF THE CLEVELAND AREA, TENNESSEE: Tennessee, Dept. Conserv., Div. Geology, Bull. 61, 125 p., 3 maps, 5 secs., 10 graphs, 6 pls. (in pocket, incl.4 geol. maps, scale 1:31,680, map, scale 1 in. to 5,000 ft., graphs),

6 tables, 1959, 56 refs.

The Cleveland area, Tennessee, is near the Georgia line and comprises some 240 sq. mi. of the Appalachian Valley and Ridge province. Paleozoic sedimentary rocks exposed in the area are strongly folded and faulted. Rocks of the Conasauga group of Cambrian age and the Knox group of Cambrian and Ordovician age underlie most of the area. Severe and prolonged weathering has leached the more soluble constituents from the near-surface rocks, leaving thick deposits of the relatively insoluble products of rock decay which effectively mask the stratigraphic and structural details of the underlying bedrock. The interpretation of the bedrock geology is based largely on the study of this residuum. In the residuum derived from the siliceous carbonate formations, particularly those of the Knox group, chert is of particular value in mapping the concealed bedrock.

Marked lithologic facies changes occur within the major rock groups from the SE. to the NW., across strike belts. The Conasauga group, in its type belt in the southeastern part of the area, consists of thick shale and minor amounts of limestone. From belt to belt, across the strike toward the NW., the quantity of limestone increases so that the limestones become persistent and well-defined units of rock which lithologically resemble the formations of the Conasauga group in northeastern Tennessee. Most of the shale-limestone sequence of rocks in the Cleveland area, however, unlike that to the NE., is of Nolichucky age. The pre-Nolichucky formations of shale and limestone in northeastern Tennessee are here represented by shales and siltstones. Formations of the Knox group, identified and mapped primarily by the study of their chert-rich residuum, become increasingly dolomitic and siliceous across the strike from the SE. to the NW. The Chickamauga limestone of Ordovician age, composed chiefly of argillaceous limestone in the northwestern belts, gives way in part to shale in the belts to the SE. where alternate shale and limestone formations are present.

Six of the major thrust faults of the southern Appalachian miogeosyncline trend northeastward through the Cleveland area. Associated with these thrusts are numerous folds and subsidiary faults. The traces of the major thrusts are rather evenly spaced across the area, and each is related to a broken fold. Along these thrust faults, Cambrian shales invariably are in contact with younger formations below; nowhere along the faults have rocks older than Cambrian been observed. Numerous klippen and other structural features associated with the faults indicate that several of the fault surfaces dip to the SE. at relatively low angles.

Overlying the Paleozoic rocks throughout much of the area is an unconsolidated residual mantle which is itself locally overlain by, or admixed with, alluvial and colluvial deposits. Accumulation of a residual mantle began near the end of Paleozoic time and is continuing at the present time. Three rather poorly defined erosional surfaces, which truncate the residuum in places and upon which gravel deposits occur, are present in the area. The oldest gravel deposit and the next youngest deposit are probably of Tertiary age. The youngest gravel deposit is of Quaternary age.

Deposits of barite, Fe, Mn, Pb, Zn, clay, tripoli, limestone, and dolomite occur in the area. The limestone and dolomite deposits, quarried chiefly for road metal, are the only deposits being worked at the present time. Barite occurs in a single area near the southern city limits of Cleveland in carbonate breccia zones in the Kingsport formation. The ore was formerly mined from residuum overlying the Paleozoic rocks. Hematite has been recovered from Fe-Mn deposits in the Red Hills district S. of Cleveland. Here the Fe and Mn occur in residual soils overlying the Holston formation. Manganese oxide deposits also are present in the weathered portions of the Fort Payne chert in the Whiteoak Mountain area NW. of Cleveland, where the Mn is Co-bearing. Pb-Zn deposits occur in the Maynardville limestone S. of Cleveland and in the Mascot dolomite N. of Cleveland. In the Whiteoak Mountain Mn district a single halloysite deposit is associated with the Fort Payne chert. Tripoli has been produced from siliceous beds of the Copper Ridge dolomite near Black Fox S. of Cleveland.

The most important aquifers in this area are the cavernous limestone and dolomite formations of the Knox group, and the most productive wells are in these rocks. The shale, siltstone, and sandstone beds are relatively poor aquifers, supplying as a rule only a few gallons of water per minute to wells. Pumping tests indicate that the permeability of the unconsolidated mantle overlying the bedrock is extremely low and that the material would yield little water to wells. A close correlation exists between the fluctuations of the water table and precipitation. Water levels generally rise in the early spring and decline to their lowest points in the autumn. Wells that yield as much as 200 g. p. m. (gallons per minute) are unusual, the majority yielding probably less than 50 g. p. m.

Springs are important for water supplies in this area. A discharge of more than 1,700 g. p. m. from a single spring system has been recorded, and several springs consistently discharge more than 200 g. p. m. Many of the larger springs flow from the Maynardville limestone. These most commonly issue from the base of ridges near the Nolichucky-Maynardville contact.

The ground waters of the area are, for the most part, of the calcium bicarbonate type. Carbonate hardness averages about 140 p. p. m. (parts per million). --Auth.

1-2201. Kuno, Hishashi. GEOLOGY AND PETROLOGY OF Ō-SHIMA VOLCANO. Translated by Kinkichi Musya and Reiko Fusejima: Internat. Geology Rev., v. 1, no. 6, p. 48-59, 3 figs. incl. 2 maps, 3 tables, June 1959, 39 refs.

Ō-shima rises from a submarine ridge extending from the Izu peninsula, central Honshū, to the Mariana arc. In the vicinity of Ō-shima, the ridge probably consists of older Miocene volcanic rocks (Yugashima group). Basalt lava and pyroclastic rocks, probably of Pliocene age, lie on the Miocene volcanics and form the direct basement of Ō-shima volcano. These rocks are now exposed in 2 separate areas, on the northern and southeastern coasts of the island, and are named the Okata basalt group and the Fude-shima basalt group, respectively. The Pliocene rocks are tholeiitic olivine basalts having compositions more mafic than the lavas of the volcano. Ō-shima volcano is a flat stratovolcano with a summit caldera within which lies an active cone, Mihara-yama. The main body is composed of thin flows of olivine-bearing tholeiitic basalt and pyroclastic layers (somma lava). There are more than 10 parasitic spatter cones, scoria cones, and pit craters arranged roughly in 3 narrow zones radiating from the center of the main body to the NW., NE.,

and SE. They probably represent rift zones comparable to those found in Fuji volcano and Hawaiian volcanos. The eruption of somma lava probably started in the late Pleistocene or early Holocene and ended with the formation of the caldera which took place within the last one or two thousand years. Mihara-yama is also a stratovolcano with a summit crater which has been active during historic time. The Mihara-yama lava (central-cone lava) is tholeiitic pyroxene basalt free from olivine and represents a more advanced stage of fractionation of basaltic magma than does the somma lava. --Auth.

1-2202. Vyalov, O. S., and V. S. Sobolev. GAUSSBERG, ANTARCTICA. Translated by L. Drashevska: Internat. Geology Rev., v. 1, no. 7, p. 30-40, 6 illus., diag., 2 tables, July 1959, 15 refs.

Gaussberg is [an extinct volcanic cone] composed of basaltic lava in which pillow structure is locally developed. The lava is a leucite basalt, not similar to rocks found within the Antarctic continent and subantarctic islands. The lava is black, scoriaceous, and without visible mineral-grain outlines. The walls of bubble cavities are lined with black volcanic glass.

The southern slope of Gaussberg is covered with small volcanic bombs or lapilli which exhibit traces of rounding of originally sharp edges. Glacial moraines contain boulders of various granites, gneisses, and schists, specifically amphibolite, biotite-garnet schist and gneiss, leucocratic biotite gneiss, granite gneiss, alaskite granite, Rapakivi-type granite, and pegmatite.

The freshness of the exposed lavas, in addition to glacial boulders found at the top of the volcanic cone, indicate that the now extinct Gauss volcano was formed before the glacial epoch, possibly in the Pliocene.

The optical constants of the principal rock-forming minerals supplement Reinisch's petrographic description of the Gaussberg lavas. Petrographic data and chemical composition indicate that the lava is an intermediate leucite basalt. A comparison of the diopside-leucite-silica equilibrium system and the values obtained in this study place the temperature of the lava between 1,150° and 1,200°C. --T. F. Rafter, Jr.

1-2203. Vyalov, O. S. ON THE GEOLOGY OF THE MIRNYY STATION AREA. Translated by Dean A. Miller: Internat. Geology Rev., v. 1, no. 6, p. 79-85, June 1959.

The U. S. S. R.-IGY Antarctic station, Mirnyy [66°31'S. 93°E.], is situated on 4 outcrops of Precambrian charnockitic granite, crystalline schist, and gneiss. The 4 mounds contain numerous angular xenoliths, generally dark schist and gneiss, denoting a palingenetic origin for the bedrock. Quartz veins and sulfide mineralization indicate later hydrothermal activity. The mounds are cut by 2 major fissure systems perpendicular to each other and several secondary fissure systems. In general, the offshore islands (the Haswell Islets) and the mounds are similar to the ancient Antarctic shield and are, therefore, considered to be a part of it. --Ed. abs.

2. GEOMORPHOLOGY

See also: Geologic Maps 1-2155, 1-2158; Areal and Regional Geology 1-2181, 1-2182; Stratigraphy 1-2241; Sedimentary Petrology 1-2365, 1-2369; Geohydrology 1-2370.

1-2204. Just, Theodor. POSTGLACIAL VEGETATION OF THE NORTH-CENTRAL UNITED STATES: A REVIEW: Jour. Geology, v. 67, no. 2, p. 228-238, March 1959, approx. 180 refs.

The dramatic changes in climate and physiography following the retreat of the last glaciers are reflected in the record of forest succession as gleaned from pollen studies made chiefly in the Great Lakes area. Fairly rapid deglaciation began about 8,500 B. C. while spruce-fir forests still dominated (Valders retreat). Soon the pine came in, and spruce-pine forests took over (about 7,000 B. C.). At the time of the terminal glacial (Cochrane, 6,000 B. C.) pine was the dominant forest tree, whereas spruce-fir forests had migrated N. During the following 3,000 years, while the climate was warmer and drier, pine forests were dominant. Then broad-leaved trees (oaks) made their appearance. First came an oak stage that extended until about 1,000 B. C. It was followed, during the next 500 years, by an oak-hickory stage. The period from 7,000 to 600 B. C. is now known as the "hypsithermal interval" rather than by its former, but less suitable, designations (postglacial climatic optimum, thermal maximum) and as such has been correlated with corresponding stages in the European sequence and postglacial chronology. The various radiocarbon dates based on different sites and carried out in different laboratories have not yet been completely aligned but show considerable agreement with other sources of evidence.

Events during late glacial and postglacial times apparently had a more far-reaching effect on present-day distribution patterns of plants and animals than did those of the various glacial and interglacial periods. These pronounced postglacial changes in climate and physiography definitely affected the mode of life of various paleo-Indian groups living in this region. --Auth.

1-2205. Terasmae, Jaan. NOTES ON THE CHAMPLAIN SEA EPISODE IN THE ST. LAWRENCE LOWLANDS, QUEBEC: Science, v. 130, no. 3371, p. 334-336, fig., Aug. 7, 1959, 14 refs.

Palynological studies, coupled with geological investigations and radiocarbon dating, have shown that the Champlain Sea episode in the St. Lawrence lowlands is in part contemporaneous with the Two Creek interstadial of the Wisconsin glaciation. --Auth.

1-2206. Brochu, Michel. GENESE DES MORAINES DES BOUCLIERS CRISTALLINS (EXEMPLE DU BOUCLIER CANADIEN) [ORIGIN OF THE MORAINES OF CRYSTALLINE SHIELDS (EXAMPLE OF THE CANADIAN SHIELD)]: Zeitschr. Geomorphologie, v. 3, no. 2, p. 105-113, May 1959; text in French, summs. in English and German.

The enormous quantity of sand and the presence of rounded granite pebbles and boulders in the moraines of the eastern part of the Canadian Shield cannot be explained as due solely to Pleistocene glaciation. Comparisons with chemically weathered masses associated with the Precambrian shield of Brazil and the Guianas support the hypothesis that the morainic material represents the product of long periods of chemical weathering under equatorial or tropical climatic conditions which obtained as far back as the Paleozoic, possibly even in the Precambrian. Transport by the inland ice sheet during Pleistocene glaciation is therefore only a late stage in the history of the moraines. --M. S.

1-2207. Leighton, Morris M. STAGNANCY OF THE ILLINOIAN GLACIAL LOBE EAST OF THE ILLINOIS AND MISSISSIPPI RIVERS: Jour. Geology, v. 67, no. 3, p. 337-344, 4 maps, May 1959, 7 refs.

The higherto unrecognized features of Leverett's ridged drift of the Kaskaskia basin throughout its course from the Shelbyville moraine in S.-central Illinois nearly to Belleville in southwestern Illinois; its genetic crevasse ridges, subcrevasse channels on the land surface, and moulin kames; together with sparse but wide distribution of similar features over the greater part of the Illinoian drift area E. of Illinois and Mississippi rivers attest to the stagnant condition of the Illinoian glacial lobe for this region after it had reached its terminus and made its marginal deposits. --Auth.

1-2208. Caldwell, Dabney W. GLACIAL LAKE AND GLACIAL MARINE CLAYS OF THE FARMINGTON AREA, MAINE - ORIGIN AND POSSIBLE USE AS LIGHTWEIGHT AGGREGATE: Maine Geol. Survey, Spec. Geol. Studies Ser., no. 3, 48 p., 12 figs., 3 fold. maps and secs., 5 tables, June 1959.

This booklet describes the geology and stratigraphy of clay deposits in the valley of the Sandy River and tributaries between Strong and Anson in southeastern Franklin County and southwestern Somerset County. The report, in 2 sections, deals first with the stratigraphy, lithology, and distribution of the glacial clay deposits. This first section also discusses the origin of the Sandy River clay deposits and their relation to glaciation. The second section describes the results of chemical and physical tests performed on samples from the Portland-Gray area in Cumberland County, Brewer in Penobscot County, and Sidney in Kennebec County. The tests included size analysis and expansion by rapid firing at high temperatures, determination of plastic properties of many of the samples, chemical tests, and strength tests of 4 concrete samples using expanded clay as a lightweight aggregate. --R. G. Doyle.

1-2209. Black, Robert F. GLACIAL GEOLOGY OF WEST-CENTRAL WISCONSIN (In: Midwestern Friends of the Pleistocene, Annual Field Conference, 10th, Eau Claire, Wisconsin, May 8-10, 1959. [Guidebook], p. 1-11, map, 1959) 19 refs.

In spite of previous correlations of glacial deposits in W.-central Wisconsin with the classical 4-fold subdivision of the Pleistocene, none older than early Wisconsin is now recognized. The early Wisconsin ice advance took place about 30,000 years ago, according to 2 C^{14} age determinations, across a forested soil derived mostly from weathered dolomite and sandstone, but possibly in part from older glacial deposits. No distinct terminal moraines are present; the ice sheet stagnated leaving many kames. The St. Croix moraine of Cary age is typical clay-silt-sand till, but the Cary ice went several miles beyond that moraine. The farthest advance toward the end of Cary times was very warm and mobile, doing little work. It is characterized by thin ice-stagnation features of relatively clean, gravelly sand. Solifluction lobes, involutions, terracettes, stone stripes, ice-wedge casts, mass-wasted scallops, and sapped cliffs point to former cold climates and to dominance of gravity movements and frost processes over stream action at some time between the early Wisconsin advance and Cary times. --Auth.

1-2210. Howard, Arthur David. NUMERICAL SYSTEMS OF TERRACE NOMENCLATURE. A CRITIQUE: Jour. Geology, v. 67, no. 2, p. 239-243, cross sec., March 1959, 16 refs.

Numerical systems of terrace nomenclature have basic defects which tend toward confusion in correlation and may lead to erroneous interpretations of regional history. A binomial system of nomenclature, similar to that used in the naming of stratigraphic formations is recommended. --Auth.

1-2211. Melton, Mark A. A DERIVATION OF STRAHLER'S CHANNEL-ORDERING SYSTEM: Jour. Geology, v. 67, no. 3, p. 345-346, illus., May 1959, 3 refs.

Channel order, according to the Strahler system, is a simple mathematical concept that can be derived from the notion of a rooted tree without first postulating the existence of a single downstream direction on each channel segment. The Strahler system is probably unique in this respect. --Auth.

1-2212. Chenoweth, Philip A. AN UNUSUAL TYPE OF RIPPLE MARK: Oklahoma Geology Notes, v. 19, no. 8, p. 154-156, 3 illus., map, Aug. 1959.

Ripple marks superficially resembling Paleozoic pararipples occur on a sand bar across Wewoka Creek, near Lima, Seminole County, Oklahoma. Their amplitude averages 4 1/2 in.; the unusual feature is that they are oriented parallel to the stream current. --M. Russell.

1-2213. Hopkins, David M. HISTORY OF IMURUK LAKE, SEWARD PENINSULA, ALASKA: Geol. Soc. America, Bull., v. 70, no. 8, p. 1033-1046, 5 figs. incl. 3 maps, profiles, Aug. 1959, 13 refs.

A study of Imuruk Lake, a large shallow lake in N.-central Seward Peninsula, Alaska, illuminates the climatic history of northwestern Alaska and the tectonic history of central Seward Peninsula during Pleistocene and Recent time. Special interest attaches to the older lake sediments, because they contain evidence concerning the climate, fauna, and flora that existed in the vicinity of Bering Strait at a time when the Bering land bridge was open, and when animal and plant populations were being exchanged between the eastern and western hemispheres.

The lake is 8 mi. long and less than 10 ft. deep; bottom sediments consisting of reworked wind-blown silt bury a rolling bedrock topography of much greater relief. Analysis of the hydrologic regime indicates

that much of the water draining into the lake is lost by evaporation; smaller quantities are lost by discharge through the outlet, the Kugruk River, and by leakage into the lava flows along the lake shore. Changes in the duration and temperature of the summer ice-free season would result in changes in the amount of water lost by evaporation and thus in appreciable changes in lake level.

Imuruk Lake occupies an initial low area on basaltic lava flows of Quaternary age, but the initial low area has been modified by faulting and now lies in a poorly defined graben. Topographic evidence confirmed by study of lacustrine terraces indicates that until recently Imuruk Lake drained westward into the Noxapaga River instead of eastward into the Kugruk River. A history of repeated warping of the lake basin, on which is superimposed a history of oscillating lake level which is due to changes in climate, is recorded by 3 systems of abandoned shoreline features found along the shores: a warped shore cliff of probable Illinoian age, a double set of warped terraces of probable Wisconsin age, and a low, horizontal terrace of Recent age. Bones of bison, horse, and mammoth were found in peaty sediments containing many twigs but no large wood; their presence indicates that these mammals, at least, were capable of surviving in a tundra environment during cold stages of the Pleistocene epoch and at a time when the Bering land bridge was in existence nearby.

The sediments filling the deeper parts of the bedrock basin of Imuruk Lake probably contain an uninterrupted pollen record that reflects vegetation changes in central Seward Peninsula beginning in middle Illinoian time and terminating a few thousand years ago. Core drilling and pollen analysis of these sediments would greatly amplify our understanding of late Pleistocene events in the vicinity of the Bering land bridge. --Auth.

1-2214. Lange, Arthur L. INTRODUCTORY NOTES ON THE CHANGING GEOMETRY OF CAVE STRUCTURES: Cave Studies, no. 11, p. 69-90, 23 figs. incl. illus., diags., map, May 1959, 5 refs.

In this paper an attempt is made to interpret the geometry of the growth of cave structures analytically, in order to recognize the processes and forms from which they evolved. The ultimate objective is to gain understanding of cave origin and past conditions by "reading" the sculpture of its walls.

The first approach is geometrical. A process p_i (for example, solution by a stream) operating on a structure s_j (e.g., a rough wall of limestone) for a period of time t is said to produce a time-stage ϕ_{ij} (possibly a scalloped wall). ϕ_{ij} is a surface, or cross section of a surface (contour), which has grown (larger or smaller) out of the initial structure, and is characteristic of that structure and the causative process.

ϕ contours resulting from the process of uniform transfer of mass between a solid and a fluid are developed for simple geometrical initial structures in cross section. Uniform transfer may be approximated in nature by the transfer taking place in a horizontal section between a cave wall and a unformly circulating fluid which favors no portion of the wall. ϕ contours evolved from circular cross sections, points, and straight-line wall sections are then combined to produce profiles resulting from the action of uniform transfer along any irregular wall The consequent modified wall can be determined graphically by rolling a circle on an axis through its center along the initial wall profile. The envelope of successive circles comprises the 2 ϕ contours of the modified wall at a time determined by the radius: an interior contour for the case of reduction of solid volume, an exterior contour for that of enlargement.

In caves, ϕ surfaces are named speleofacts, representing cave structures in general. These include speleothems, formed by enlargement of the volume of the solid structure, and speleogens, formed by reduction of its volume. Examples of each, believed to have formed under the conditions of uniform transfer, are shown to have the predicted geometrical properties. These include dissolved joints, encrusted walls, and gours, or rimstone dams. The need for much additional field examination, in the light of this technique of interpretation, is stressed.

A mathematical development of the argument is then given, confirming the geometrical conclusions. Finally, 2 laboratory experiments in which salt blocks were dissolved are described. The dissolved blocks conform to the predicted shapes. --Auth.

1-2215. Tuan, Yi-Fu. PEDIMENTS IN SOUTHEASTERN ARIZONA: California, Univ., Pubs. Geography, v. 13, p. 1-164, 35 illus. on 11 pls., 47 figs. incl. maps (1 fold.), cross secs., profiles, 2 tables, 1959, 66 refs.

"The pediment is the piedmont surface that cuts across the rock formations of the mountain ranges. It slopes away from the residual mountain and is commonly fringed by an alluvial apron or by a degradational surface developed on old alluvium." Lawson's and Johnson's hypotheses of pediment origin, also the concept of exhumation, are briefly examined. The purpose of this study was to test the relative merits of the various hypotheses on pediment formation by an intensive survey and mapping of a series of pediments in southeastern Arizona S. of the Gila River, E. of the Santa Cruz and Altar valleys, and W. of the Sulphur Spring Valley.

In the second section of the paper the topography of this area and the structure of individual ranges and basins are described, then individual pediments of the Tucson, Sierrita, and Sacaton mountains, Tortilla Mountains and Black Mountain, Tortolita, Santa Catalina, and Huachuca mountains, Johnny Lyon Hills, Little Dragoon, and Dragoon mountains. The third and final section of the paper consists of a synthesis dealing with types of pediment in southeastern Arizona, relations between environment and pediment, review and evaluation of major hypotheses on pediments and a synthesis of theories of origin:

"There are 5 major types of pediments in southeastern Arizona: 1) the Huachuca type, 2) the Sacaton type, 3) the Tucson (volcanic) type, 4) the Northwest Dragoon type and 5) the Sierrita type. The origin of each type, their relation to one another, and their place in the degradational sequence need now be considered within the framework of a comprehensive theory.

Evidence derived from observation of the pediments in southeastern Arizona supports a theory of exhumation that is closely akin to A. C. Lawson's deductive analysis of the development of the suballuvial bench... The main theme of the theory of exhumation may be stated as follows:

The tectonic relief of the basin and range province

is subdued, partly by degradational and partly by aggradational processes. The degradational processes produce 2 types of rock surface: the mountain front, and the suballuvial bench. As the height of the mountain front diminishes toward the end of the degradational sequence, the suballuvial bench attains its maximum extent. At this stage the visible elements of the landscape are composed of small mountain residuals surrounded by broad alluvial aprons.

The sequence of development from a high mountain front bordered by a narrow suballuvial bench to a low mountain front bordered by a broad suballuvial bench requires tectonic stability. If at some part-way stage in the sequence the slope of the piedmont were increased by the downward erosion of the axial stream, the local base level, or by a relative uplift (doming or block faulting) of the mountain range, the degradation of the alluvial apron would reveal the suballuvial bench as a visible element of the profile. The area of the exhumed suballuvial bench (the pediment) depends on the stage of the degradational sequence. If exhumation takes place during an early stage of the degradational sequence, the exposed pediment is narrow; if it occurs late in the sequence, the exposed pediment can be broader, depending on the size of the structural block and on the extent of removal of the alluvial cover.

The theory of the origin of pediments in southeastern Arizona rests partly on the tectonic history of the region, since tectonic relief is the foundation upon which degradational processes produce the mountain front and the suballuvial bench."--A. C. Sangree and auth. summ.

1-2216. Ljunggren, Pontus. A MINERALOGICAL EXAMINATION OF SOME SOIL SAMPLES FROM SOUTHERN AND CENTRAL HONDURAS: Kgl. Fysiog. Sällsk. Lund, Förh., v. 28, no. 13, p. 125-131, illus. incl. geol. sketch map, 1958, pub. 1959; summ. in Spanish.

Soil samples from 2 regions in Honduras are examined by means of differential thermal analysis, X-ray analysis, and optical methods. It is shown that the highland soils are dominated by kaolinite and montmorillonite, whereas the lowland soils from southern Honduras are characterized by considerable quantities of hydrous alumina minerals. The possibilities of finding exploitable bauxite deposits are discussed. --Auth.

1-2217. Bascom, Willard. OCEAN WAVES: Sci. American, v. 201, no. 2, p. 74-84, 9 illus., map, 3 secs., Aug. 1959.

Men have always been fascinated, sometimes awed, and at times profoundly affected and concerned by the rhythmic motions of the sea's surface. A century of observation and experimentation has revealed much about how waves are generated and propagated. The first wave experimentalists were Ernst and Wilhelm Weber who confirmed that wave particles move in a circular orbit. Most ocean waves are caused by the wind, and, although the geometry and elements of wave origin and motion can be simply stated, actual waves are the complex result of so many variables that statistical analyses are necessary to understand them.

Storm waves commonly reach heights of 40 to 80 ft.; the highest to be accurately calculated was 112 ft. The effect of waves on the shore is closely related to the configuration of the shoreline and the offshore ocean bottom; sharp headlands, for example, receive far more wave energy per unit of shore length than do shores concave to the direction of the ocean. Examples of damage to shoreline features are given to illustrate the power of waves. The most destructive wave form is the seismic sea wave or tsunami caused, not by wind, but by sudden displacement of the ocean floor, in turn caused by earthquakes, landslides, or volcanos. As the earth waves generated by the displacement can be recorded by seismographs, tsunamis can often be predicted hours before they strike. A tsunami caused by the explosion of Krakatoa in 1883 killed over 35,000 people, and a tsunami in the Bay of Bengal in 1876 killed 200,000 people.

The normal tides caused by the force of gravity of the moon and sun, seiches (waves of reflection within a closed basin), undersea waves along the thermocline, and waves caused by rapid variations in barometric pressure are other types of waves which are known and are being studied. Experimental tanks to simulate wave forms and action aid in the design of ships and the understanding of shore features --M. Russell.

1-2218. Zeigler, John M., Carlyle R. Hayes, and Sherwood D. Tuttle. BEACH CHANGES DURING STORMS ON OUTER CAPE COD, MASSACHUSETS: Jour. Geology, v. 67, no. 3, p. 318-336, 4 illus. on 2 pls., 9 maps, 4 profiles, 2 diags., 2 graphs, 5 tables, May 1959, 15 refs.; also pub. as: Woods Hole, Mass., Oceanog. Inst., Contr. no. 956.

Effects on beaches of 9 storms and 2 hurricanes have been measured on the beaches of Cape Cod. Changes in beach volume and topography take place very rapidly, and vertical cuts of 9 ft. in the foreshore and volume changes of as much as 520 cu. ft. per linear foot during one tide have been measured. The positions of offshore shoals influence the amounts of beach erosion, with cutting being greater behind openings in the bars. Migration of openings in the bars shifts the locus of maximum cut and fill laterally along the beach. Wave erosion at the base of the cliffs, while occurring irregularly, is important as it increases the rate of mass wastage in the slopes. --Auth.

1-2219. Zenkovitch, V. P. ON THE GENESIS OF CUSPATE SPITS ALONG LAGOON SHORES: Jour. Geology, v. 67, no. 3, p. 269-277, 4 illus. on 2 pls., 6 figs. incl. 2 maps, May 1959, 18 refs.

In Fisher's article [Geological Abstracts, v. 3, no. 2, p. 19, June 1955] unusual beach projections (cuspate spits) in the lagoons of St. Lawrence Island, Alaska, were described. The question of their formation remained unsettled and led to further discussion by Price and Wilson. The present author reports the data obtained while the problem was studied by the scientists of the U. S. S. R. There exist similar projections in the numerous lagoons of the northeastern part of the U. S. S. R., as well as in a number of other narrow gulfs. Their formation reflects peculiarities of shores of elongated water bodies in which the resultant wave regime is oriented at an acute angle toward the shore. Cuspate spits are formed by shore-drifting processes and do not result from seiches, as suggested by Price and Wilson. --Auth.

1-2220. UNDERWATER DISCOVERIES IN THE STRAITS OF FLORIDA: Military Engineer, v. 51,

no. 343, p. 403, Sept.-Oct. 1959.

During hydrographic surveys by the U. S. Coast and Geodetic Survey, sinkholes as large as a half mile in diameter and 500 ft. deep were discovered in the Straits of Florida 14 mi. offshore from the Florida Keys where the ocean bottom is 900 ft. deep. They are presumed to have been fresh-water lakes in an area which subsided.

A mile-high sea scarp rises from 10,000-ft. depths in the Gulf of Mexico 150 mi. off the W. coast of Florida. Other vertical displacements of the sea bottom were found nearer shore. --M. Russell.

1-2221. UNDERWATER LAGOON: Military Engineer, v. 51, no. 343, p. 404, Sept.-Oct. 1959.

During hydrographic surveys by the U. S. Coast and Geodetic Survey, a drowned barrier beach with a lagoon inside it and a channel running down the lagoon was discovered in 500 ft. of water, 150 mi. W. of Key West in the Gulf of Mexico. The feature is 65 mi. long and has been named Howell Hook. Inferences on prevailing currents and nature of sedimentation while it was being formed can be made from its configuration and state of preservation. --M. Russell.

1-2222. Bird, J. Brian. RECENT CONTRIBUTIONS TO THE PHYSIOGRAPHY OF NORTHERN CANADA: Zeitschr. Geomorphologie, v. 3, no. 2, p. 151-174, illus., May 1959; summs. in German and French.

Regional exploration and reconnaissance since 1945 have increased knowledge of the physiography of northern Canada, previously known only on a local scale from observations in isolated localities.

A major Tertiary erosion surface has been traced through the eastern part of the Mackenzie region, on Baffin Island, and in northern Quebec. It is in an advanced stage of maturity and consists essentially of a smooth surface at an elevation of 1500-2000 ft. (450-600 m.), above which some monadnocks rise. Toward the NE., it is replaced by a highly dissected surface at an elevation of 5000-6000 ft. (1500-1800 m.). Other surfaces are also present at elevations above 1500-2000 ft., of which one of the most extensive is the one discovered in the vicinity of the Lancaster and Barrow straits, probably representing a major stillstand of the sea in preglacial time.

Although no conclusive evidence of pre-Wisconsin glaciation has been found, observations indicate the possibility of repeated glaciation of the region. The inland ice sheet is considered to have grown by amalgamation of many small ice caps and to have extended toward the W. and SW., probably covering the whole of northern Canada east of the Cordillera. Marine transgressions have been the most significant agent in the sculpturing of the relief in postglacial time. --M. S.

1-2223. Shimer, John A. THIS SCULPTURED EARTH: THE LANDSCAPE OF AMERICA: 255 p., illus., maps, diags., New York, Columbia University Press, 1959.

The origin of the varied landscapes of the United States is explained for the general reader and illustrated with many black and white photographs, some maps and diagrams. Topics covered include: the meaning of scenery, coastal landscapes, glacial landscapes, plains, plateau country, volcanic landscapes, mountain scenery, the work of water on the surface and underground. The text is followed by a glossary of common geologic terms, some illustrated. --A. C. Sangree.

1-2224. Itter, Harry Augustus. THE GEOMORPHOLOGY OF THE WYOMING-LACKAWANNA REGION: Pennsylvania Geol. Survey, Bull. G9, 82 p., 17 illus., map on 9 pls., 33 maps, 23 secs., 5 block diags., 1938, reprinted 1959, 11 refs.

The Wyoming-Lackawanna Valley is perhaps best known to geologists as the Northern Anthracite field of Pennsylvania. Geologists have for the most part concerned themselves with structural and economic problems incident to the removal of the coal, hence other problems have been somewhat neglected.

This paper must not be construed as one dealing with the economic geology of the area but as a paper dealing with the problems associated with the development of the land forms. The paper is developed along 2 different lines. Pt. I has been written primarily for the layman residing in the region who has had little or no geologic training. Part II deals with certain important geomorphic problems of the area presented in a manner somewhat more technical than in Pt. I.

The Wyoming-Lackawanna area presents a number of problems relating to the major drainage. These should be examined in the light of the Davisian and Johnsonian theories and should fit into the scheme suggested by one or the other or else indicate the need for yet another interpretation. The writer has studied these problems in detail in an attempt to find what theory most adequately and rationally explains them.

The general discussion dealing with the erosional history of the region is based on concepts originally developed by William Morris Davis and modified to some extent by the studies of Douglas W. Johnson. More recent investigations, particularly those of Dr. George H. Ashley, seem to indicate that there may possibly have been but one peneplane high above any present level and that the present accordant surfaces (Schooley, Harrisburg, Somerville peneplanes of the older concept) are the result of differential erosion and do not represent peneplanes in the usual meaning of the term.

If the Fall Zone peneplane of Johnson is conceded to be the same as this older higher peneplane of Ashley, the sequence of events as indicated in this paper will in general hold true. The reader will bear in mind that instead of having several periods of Tertiary peneplanation, each interrupted by specific uplift, there will be but one extensive erosional period and the accordant surfaces as seen today must be construed as the result of differential erosion. --Auth.

See also: Areal and Regional Geology 1-2179, 1-2180, 1-2194; Geophysics 1-2283; Fuels 1-2389.

1-2225. Malde, Harold E. FAULT ZONE ALONG NORTHERN BOUNDARY OF WESTERN SNAKE RIVER PLAIN, IDAHO: Science, v. 130, no. 3370, p. 272, July 31, 1959, 7 refs.

Gravity, seismic, and geologic studies indicate that at least 9000 ft. of aggregate throw along a zone of NW.-trending high-angle faults has displaced the western Snake River plain downward relative to highlands on the N. At least 5000 ft. of movement occurred between the early and middle Pliocene. Progressively diminishing movement since then amounts to 4000 ft. --Auth.

1-2226. Moebs, N. N., and Robert B. Hoy. THRUST FAULTING IN SINKING VALLEY, BLAIR AND HUNTINGDON COUNTIES, PENNSYLVANIA: Geol. Soc. America, Bull., v. 70, no. 8, p. 1079-1088, 7 figs. incl. 3 maps, secs., chart, Aug. 1959, 10 refs.

Sinking Valley, Pennsylvania, is floored by Cambro-Ordovician limestone and dolomite which are folded into an asymmetrical anticline overturned to the NW. Information obtained from diamond-drill cores indicates an extensive thrust fault, accompanied by subsidiary branching offsets, which has displaced the steeply dipping northwestern limb of the anticline about 2 mi. --Auth.

1-2227. Jones, R. W. ORIGIN OF SALT ANTICLINES OF PARADOX BASIN: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 8, p. 1869-1895, 11 figs. incl. 5 maps, 2 secs., Aug. 1959, 34 refs.

The origin of the stress that initiated the deformation of the salt anticlines of the Paradox basin [Utah-Colorado] has been attributed by previous investigators either to compressional folding or to deep-seated faulting. There is little independent evidence to indicate that either type of deformation was active at the right time and place.

In this paper evidence is presented to support the idea that the salt anticlines were initiated by the differential loading of the salt-bearing Pennsylvanian Hermosa formation by the Permian Cutler formation. The supporting evidence includes the following items: 1) the necessary stress was available; 2) many of the individual features of the anticlines are in agreement with theory and experiments based on a differential loading hypothesis; 3) the time of origin of the anticlines is as predicted by the differential loading hypothesis; and 4) the anticlines probably formed in sequence from NE. to SW. as required under a differential loading hypothesis. --Auth.

1-2228. Gorzhevsky, D. I., and G. F. Yakovlev. EVIDENCE OF THE TELBESS PHASE OF TECTOGENESIS IN RUDNY ALTAI. Translated by L. Drashevska: Internat. Geology Rev., v. 1, no. 6, p. 60-65, 2 charts, June 1959, 8 refs.

Traces of Telbess tectogenesis in Rudny Altai [western Altai mountains, approx. 50°N. 83°E.] are described, and their importance in the geologic history of the area is shown. The Telbess phase of folding was extensive; disturbances of varying scale and in different mobile zones occurred. The tectonic activity is indicated mainly by faults along which tectonic blocks were displaced. The folds often have slanting bottoms or arches and steeply dipping flanks. The Telbess phase of folding was accompanied by the intrusion of granite, volcanic activity, and sediment accumulation. --Auth.

1-2229. Reitan, Paul H. A HYPOTHESIS ACCOUNTING FOR A TWO-PHASE OROGENIC CYCLE: Jour. Geology, v. 67, no. 2, p. 129-134, 2 figs., March 1959, 34 refs.

A modification of the theory of mountain-building due to convection currents in the mantle is offered. The hypothesis accounts for a 2-phase orogenic cycle, first tensional and then compressional: the 2-phase cycle results from the rock-back of the convection cell. Rock-back follows as a consequence of certain reasonable assumptions made about the mantle. The 2-phase orogenic cycle is in harmony with and is demanded by geological observations. --Auth.

1-2230. Flawn, Peter T. OUACHITA BELT AND ARBUCKLE ELEMENT: INTERPRETATION: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 8, p. 2012-2015, map, Aug. 1959.

A map, scale 1 in. to 15 mi., shows a structural interpretation of the Ouachita-Arbuckle junction in SE. Oklahoma-NE. Texas. Data from wells have made possible the mapping of the southeastern extent of the Arbuckle element. A major tectonic event involved large-scale tear faulting, wherein a deformed Ouachita prism was moved northwestward relative to the Arbuckle mass. --M. Russell.

1-2231. Douglas, G. Vibert. THE GEOLOGICAL STRUCTURE AND GROWTH OF THE CARIBBEAN AREA: Nova Scotian Inst. Sci., Proc., v. 24, pt. 3, p. 297-302, map, 3 secs., 1956-1957, pub. Dec. 1958, 7 refs.

The greater and lesser Antilles owe their origin to the existence of mountain trend lines which are part of the western cordillera of North and South America. The relief of these mountains considered from the adjacent ocean deeps to the summit of Puerto Trujillo is greater than that between the Bay of Bengal and Mount Everest.

The development of the present geology is connected to the erosion of the emergent peaks, the growth of fringing coral reefs, and vulcanism. --Auth.

1-2232. King, B. C., and N. Rast. STRUCTURAL GEOMETRY OF DALRADIAN ROCKS AT LOCH LEVEN, SCOTTISH HIGHLANDS: A DISCUSSION: Jour. Geology, v. 67, no. 2, p. 244-246, table, March 1959, 6 refs.

The methods and conclusions of L. E. Weiss and D. B. McIntyre (Jour. Geology, v. 65, p. 575-602) are most to be criticized in that, by relying almost entirely on geometric analysis, to the exclusion of evidence based on stratigraphic studies, the really fundamental structures, the great recumbent folds or nappes, are not adequately demonstrable. The following interpretation of the structures in the Ballachulish-Loch Leven area is proposed: 1) Large-scale recumbent folding on NE.-SW. axes with anticlinal cores directed toward the NW. Despite the

great translation, associated small-scale structures are difficult to detect. 2) Cross-folds, ubiquitous on a small scale, plunging approximately down the dip of the layering produced by 1 and represented by a major asymmetric fold to the S. of Loch Leven. 3) Folds with steep axial planes, plunging gently to the SW. (the "mappable folds"), which are responsible for the generally steep plunge of the minor cross-folds. Although we should describe only 1 and 3 as Caledonoid, all are episodes of Caledonian movements. It is also likely that there is not a sharp separation in time and that some measure of contemporaneity of 1 and 2, and of 2 and 3 is to be supposed." A table comparing this interpretation of King and Rast with the conclusions of Bailey, and Weiss and McIntyre is included. --M. Russell.

1-2233. Bailey, E. B. STRUCTURAL GEOMETRY OF DALRADIAN ROCKS AT LOCH LEVEN, SCOTTISH HIGHLANDS: A DISCUSSION: Jour. Geology, v. 67, no. 2, p. 246-247, March 1959, 6 refs.

L. E. Weiss and D. B. McIntyre (Jour. Geology, v. 65, p. 575-602) use a technique which could never satisfactorily reveal complicated structures. They arrived at mutually contradictory conclusions in deducing a Mam na Gualainn fold and a Loch Leven fold. --M. Russell.

1-2234.Weiss, L. E., and D. B. McIntyre. STRUCTURAL GEOMETRY OF DALRADIAN ROCKS AT LOCH LEVEN, SCOTTISH HIGHLANDS: A REPLY: Jour. Geology, v. 67, no. 2, p. 247-249, March 1959, 11 refs.

The individual points raised in the discussions of King and Rast and of Bailey (see above) are commented upon, and clarification made of most. The value of making detailed studies of the geometry of folding in working out the structural relations of this and similar areas is reemphasized. --M. Russell.

1-2235. Korn, Hermann, and Henno Martin. GRAVITY TECTONICS IN THE NAUKLUFT MOUNTAINS OF SOUTH WEST AFRICA. Translated by John G. Dennis: Geol. Soc. America, Bull., v. 70, no. 8, p. 1047-1077, 18 figs. incl. map, secs., diags., 8 pls. incl. fold. geol. map scale approx. 1 in. to 3 mi., fold. secs., fold. profiles, table, Aug. 1959, 15 refs.

The late Precambrian Nama beds of the Naukluft mountains in South West Africa show intense Alpine-type deformation.

The crystalline basement underlying these rocks is little disturbed. Its upper surface is basin-shaped. The intensity of deformation in the overlying Nama beds increases upward to a practically undeformed unconformity which separates the Nama into 2 folded units. The unconformity is overlain by a strikingly uniform and little disturbed dolomite bed. Above this dolomite the intensity of deformation once more increases; it reaches its maximum in this upper deformed unit. The folds delineate a cascading movement from the topographically higher northern hinterland and form a great arc in front of the steepest slope of the basin, overriding the undeformed Nama beds of the southern foreland in a number of thrust sheets and nappes.

These observations, based on detailed mapping from exceptionally favorable exposures, bring out a movement pattern which is plainly controlled by the shape of the basin. Such a pattern is best interpreted as due to plastic flow under the influence of gravity. --Auth.

4. STRATIGRAPHY AND HISTORICAL GEOLOGY

See also: Geologic Maps 1-2162; Areal and Regional Geology 1-2169 through 1-2178, 1-2189, 1-2193, 1-2194; Geomorphology 1-2205; Geophysics 1-2279, 1-2282; Sedimentary Petrology 1-2363, 1-2364; Mineral Deposits 1-2376, 1-2378; Fuels 1-2387.

1-2236. Schindewolf, Otto H. ON CERTAIN STRATIGRAPHIC FUNDAMENTALS. Translated by P. F. Moore: Internat. Geology Rev., v. 1, no. 7, p. 62-70, chart, July 1959, 23 refs.

Stratigraphic fundamentals, rules, terminology, and nomenclature require extensive clarification for universal usability. At present, little agreement on stratigraphic definitions and terminology has been reached. Three systems of terminology must be distinguished: 1) prostratigraphy, or preliminary stratigraphy without chronology; 2) stratigraphy, which is intimately concerned with time; and 3) chronology, or absolute time measurement without regard to rock units and their correlation. The Hedberg system of lithostratigraphy, biostratigraphy, and chronostratigraphy is discussed. A glossary of the terminology of stratigraphic and chronologic units is established. --G. E. Denegar.

1-2237. Rodgers, John, and Richard B. McConnell. NEED FOR ROCK-STRATIGRAPHIC UNITS LARGER THAN GROUP: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 8, p. 1971-1975, table, Aug. 1959, 8 refs.

One or more categories of rock-stratigraphic units larger than group are needed in stratigraphic practice, especially in the Precambrian. The proposal to use series and system for such units would lead to unfortunate confusion between rock-stratigraphic and time-stratigraphic units. Among possible terms for such categories are: assemblage, bloc, complex, sequence (and sub-sequence), suite, super-group. --Auth. summ.

1-2238. Wheeler, Harry E. UNCONFORMITY-BOUNDED UNITS IN STRATIGRAPHY: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 8, p. 1975-1977, Aug. 1959, 3 refs.

The American Commission on Stratigraphic Nomenclature is urged in its consideration of a forthcoming code to incorporate specific provision for suites of rock which are bounded by unconformities and which are not necessarily time-stratigraphic units. The words constratation or succession are suggested to apply to such a unit. --M. Russell.

1-2239. Griggs, Roy L., and C. B. Read. REVISIONS IN STRATIGRAPHIC NOMENCLATURE IN TUCUMCARI-SABINOSO AREA, NORTHEASTERN

NEW MEXICO: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 8, p. 2003-2007, map, chart, Aug. 1959, 5 refs.

It is proposed to revise the stratigraphic nomenclature of rocks in the Tucumcari-Sabinoso area in Guadelupe, Harding, San Miguel, and Quay counties in northeastern New Mexico. The following terminology for the Triassic, Jurassic, and Cretaceous units are proposed.

Cretaceous (3 formations)
- Pajarita shale
- Mesa Rica sandstone
- Tucumcari shale

Jurassic (3 formations)
- Morrison formation
- San Rafael group (2 formations)
  - Bell Ranch formation
  - Entrada sandstone

Triassic (3 formations)
- Redonda formation
- Dockum group (2 formations)
  - Chinle formation
  - Santa Rosa sandstone

--M. Russell.

1-2240. Afonichev, N. A. SILURIAN DEPOSITS OF THE NORTHERN SLOPE OF THE DZHUNGARIAN ALATAU. Translated by L. Drashevska: Internat. Geology Rev., v. 1, no. 6, p. 66-73, 2 illus., 2 maps, June 1959, 7 refs.

Silurian deposits were first identified on the northern slope of the Dzhungarian Alatau [approx. 45°N. 80°E.] by F. A. Makarenko on the basis of fauna collected in the Aksu river basin. In 1938, Silurian deposits, 400 km. in length, were mapped by M. M. Yudichev. Later investigations have shown that these beds are Devonian in age. It seems obvious that Paleozoic sediments unconformably overlying the Precambrian(?) crystalline foundation began accumulating in the Lower Devonian. The principal Paleozoic structures are the result of Hercynian folding, not the final phase of Caledonian folding, as assumed by Makarenko. --Auth.

1-2241. Lecompte, Marius. CERTAIN DATA ON THE GENESIS AND ECOLOGIC CHARACTER OF FRASNIAN REEFS OF THE ARDENNES. Translated by P. F. Moore: Internat. Geology Rev., v. 1, no. 7, p. 1-23, 15 illus., map, 9 secs., July 1959, 40 refs.

The confinement of origin and development of modern coral reefs to the zone of turbulence is apparently linked to the symbiosis of corals and zooxanthellids. The Frasnian (Devonian) reefs of the Ardennes (Belgium) were constructed by stromatoporoids or corals, with associated marine forms. Reefs formed of massive stromatoporoids developed in the zone of turbulence; coral reefs were constructed beneath this zone; and mixed reefs either started in one environment and shifted to another or developed in an intermediate zone. To each one of these environmental conditions there corresponds a particular morphologic structural type. --G. E. Denegar.

1-2242. Willis, Ronald P. UPPER MISSISSIPPIAN-LOWER PENNSYLVANIAN STRATIGRAPHY OF CENTRAL MONTANA AND WILLISTON BASIN: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 8, p. 1940-1966, 11 illus. on 2 pls., 9 maps, 2 charts, 2 secs., Aug. 1959, 20 refs.

Tyler formation is the name of the rock sequence between the black shales of the Heath formation and the carbonates of the Amsden formation (restricted). The Tyler formation is divided into 2 members, and the division is made at the base of the "A" zone, which consists of the Bear Gulch limestone tongue and its sand equivalent. The upper member is called the Cameron Creek member. The Alaska Bench limestone is considered a member of the Amsden formation (restricted). The sand map of the Tyler formation shows what is believed to have been a normal marine to restricted beach-offshore bar type of depositional environment. This is true both in central Montana and Williston basin, but the erosional unconformity at the base of the Tyler formation is evident only in central Montana. The sands in the lower member of the Tyler formation in central Montana are called the Sumatra sands. The upper sand in the Tyler-Heath of Williston basin is termed the Fryburg sand, and the middle sand is the Fritz sand. The age of the Heath formation is believed to be Late Chester, whereas the overlying Tyler formation is Early Pennsylvanian (Morrow). The Amsden formation (restricted) is dated as Morrow-Atoka. --Auth.

1-2243. Blythe, Jack G. ATOKA FORMATION ON THE NORTH SIDE OF THE McALESTER BASIN: Oklahoma Geol. Survey, Circ. 47, 74 p., 24 illus., 1959, 45 refs.

The Atoka formation [Pennsylvanian] of the shelf area of northeastern Oklahoma is a lithologic complex characterized by intricate facies changes as a result of multiple source areas and varying degrees of tectonic behavior in source areas and depositional sites.

Three major source areas are evidenced: the Ouachita Mountain area of southeastern Oklahoma and SW. central Arkansas; the Ozark uplift in northeastern Oklahoma, northwestern Arkansas, and southern Missouri; and the cratonal area to the N. and NW. in northern Oklahoma and Kansas.

The Atoka units of the McAlester basin area include great accumulations of shale and are believed to constitute a molasse-type deposit from the Ouachita area. Much of the thinner portions of the shelf section of the Atoka formation involve sediments derived from the Ozark uplift to the E. and the cratonal shores to the N.

Many lower and middle Atoka sandstones are subgraywackes, although the Pope Chapel sandstone of the shelf area exhibits a greater degree of sorting and a closer approach to a shelf type "blanket" sand than do other Atoka units. Georges Fork-Dirty Creek sandstones are subgraywackes which accumulated on a somewhat unstable shelf area. The Webbers Falls member attests to clearing seas and a low-lying source area. The uppermost Atoka unit, or Blackjack School member, is a micaceous sandstone deposited in the Atoka seas during their maximum northward extent. The progressive northward advance of Atoka seas is evidenced by the overlap northward of younger Atoka units beyond older members.

A prominent disconformity at the base of Atoka strata is believed to correlate in time with the Wichita orogeny of southern and southwestern Oklahoma and the Ouachita orogeny of southeastern

Oklahoma. A time break at the top of the Atoka section is not readily apparent in the field, but may be inferred from faunal evidence.

The most significant faunal elements for identifying Atoka strata are fusulinids, with certain species of Fusulinella, Fusiella, Profusulinella, Eoschubertella, Pseudostaffela indicative of Atokan age. Cephalopods, such as Pseudoparalegoceras williamsi, and other forms, hold promise as Atokan age delineators.

The Atoka formation includes numerous oil-producing sands, known as Dutcher and Gilcrease, in the subsurface of eastern and E.-central Oklahoma. These sands are markedly lenticular, so that localized and highly variable production characterizes areas of Atoka fields. --Auth. summ.

1-2244. Bolyard, Dudley W. PENNSYLVANIAN AND PERMIAN STRATIGRAPHY IN SANGRE DE CRISTO MOUNTAINS BETWEEN LA VETA PASS AND WESTCLIFFE, COLORADO: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 8, p. 1896-1939, illus., 10 maps, chart, 3 secs., 2 graphs, table, Aug. 1959, 48 refs.

Structurally complex Pennsylvanian and Permian strata comprise the bulk of the Sangre de Cristo Range between La Veta Pass and Westcliffe in S.-central Colorado. They are at least 14,000 ft. thick near Crestone in the northern part of the area, and more than 9,000 ft. thick at La Veta Pass on the S. The sediments are predominantly arkosic clastics, eroded from Precambrian crystalline rocks of the San Luis-Uncompahgre highland on the W., and rapidly deposited in a narrow, NW.-trending geosyncline. This sector of the Sangre de Cristos is nearly parallel with the geosyncline and situated near its western side. The terrigenous clastics become finer grained and Des Moinesian limestones become abundant southeastward, reflecting southward decrease in uplift of the highland and a more basinward position of the southern exposures.

The Kerber formation (Morrowan?), oldest Pennsylvanian unit in this area, apparently can be recognized only at Grayback Mountain, W. of Huerfano Park; presumably it was partly removed by erosion prior to Atokan deposition.

The name Deer Creek formation is proposed for beds previously called Clastic member of the Sandia, from Huerfano River S. to the New Mexico border. At its type locality, W. of Huerfano Park, this formation is late Atokan, 1,119.2 ft. thick, and consists of variegated sandstones, siltstones, conglomerates, and shales chiefly of fluvial origin, with interbedded marine limestone and terrigenous clastics in the upper part. The Deer Creek formation is differentiated by its redbeds.

The Madera formation contains Fusulina rockymontana (Roth and Skinner) and is of Des Moinesian age. At La Veta Pass it is about 3,068 ft. thick and is divided into the lower, Gray limestone member, 533 ft. thick; the Arkosic limestone member, 2,369 ft. thick; and the upper, Whiskey Creek Pass limestone member, 166 ft. thick. The first 2 member accumulated under alternating marine and fluvial environments. The increasing predominance of continental sediments in the Arkosic limestone member reflects eastward migration of the shore line. The Whiskey Creek Pass limestone records stability in both depositional and source areas.

The Madera grades northward into its stratigraphic equivalent, the Minturn formation. The Minturn is at least 5,000 ft. thick and consists chiefly of grayish to greenish sandstones, conglomerates, and shales or siltstones. It is mainly fluvial, but marine sediments occur at several horizons. Near the top, a calcareous zone containing marine fossils is probably equivalent to the Whiskey Creek Pass limestone.

Overlying the Madera near La Veta Pass and Pass Creek Pass is a sandstone section about 1,000 ft. thick, in fault contact with the overlying Sangre de Cristo formation. It is here named the Pass Creek sandstone.

The Sangre de Cristo formation, of late Pennsylvanian(?) and probably Permian (Wolfcamp) age, contains up to 8,000 ft. or more of predominantly fluvial strata. It is differentiated from underlying units by its redbeds. Two members are recognized in the northern part of the area: the Lower member, characterized by piedmont cyclothems; and the Crestone conglomerate. The latter, a thick fanglomerate, is the only positive evidence of mountains in the San Luis-Uncompahgre highland, and is the last record of Paleozoic orogeny in this area. --Auth.

1-2245. Shoemaker, Eugene M., and William L. Newman. MOENKOPI FORMATION (TRIASSIC? AND TRIASSIC) IN SALT ANTICLINE REGION, COLORADO AND UTAH: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 8, p. 1835-1851, map, Aug. 1959, 31 refs.

The Moenkopi formation of Traissic(?) and Triassic age is widely exposed in the salt anticline region in southeastern Utah and southwestern Colorado. The distribution of the Moenkopi is that of a blanket of irregular thickness with several large holes in it, due to nondeposition and pre-Chinle erosion.

Four members of contrasting lithology have been mapped in the Moenkopi in the salt anticline region. In ascending order these members are: 1) the Tenderfoot member, composed dominantly of muddy or silty, poorly sorted sandstone; 2) the Ali Baba member, composed of interstratified arkosic conglomeratic sandstone and fissile siltstone; 3) the Sewemup member, composed dominantly of fissile siltstone with minor beds of conglomeratic sandstone and gypsum; and 4) the Pariott member composed of interstratified sandstone and siltstone.

Part of the Tenderfoot member of the Moenkopi formation is correlative with the Hoskinnini member of the Moenkopi formation of southeastern Utah, a unit which may be either Permian or Early Triassic in age or possibly both. If equivalents of the type Moenkopi of northeastern Arizona are present in the salt anticline region they may include the upper part of the Sewemup member and part or all of the Pariott member. --Auth.

1-2246. Stewart, John H. STRATIGRAPHIC RELATIONS OF HOSKINNINI MEMBER (TRIASSIC?) OF MOENKOPI FORMATION OF COLORADO PLATEAU: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 8, p. 1852-1868, map, 3 secs., Aug. 1959, 17 refs.

Recent work on strata of Permian and Triassic age on the Colorado Plateau indicates that the unit originally defined as the Hoskinnini tongue of the Cutler formation extends into parts of southeastern Utah where it had not been previously reported. In addition, the Hoskinnini is correlated with part or all of the unit defined as the Tenderfoot member of the Moenkopi formation in the salt anticline region

of E.-central Utah and W.-central Colorado. As a result of this work, the Hoskinnini is redefined as the Hoskinnini member of the Moenkopi formation. The Hoskinnini and laterally continuous strata in the Tenderfoot member are exposed within a NNE. oriented area about 180 mi. long and 50 mi. wide extending from the Monument Valley area, in northeastern Arizona and southeastern Utah, to W.-central Colorado. Previously the Hoskinnini had been recognized only in the Monument Valley area.

The Hoskinnini member and laterally continuous strata in the Tenderfoot member are pale reddish brown sandy siltstone grading to silty very fine-grained sandstone and contains disseminated fine, medium, and coarse quartz grains. The Hoskinnini is composed of horizontal beds, which generally range from 1 to 2 ft. in thickness. Individual beds are marked by indistinct discontinuous wavy laminae bounded by grayish red claystone or siltstone films. The Hoskinnini is 50-120 ft. thick in most areas.

The combination of fine to coarse sand grains in a silt or very fine-grained sand matrix and of discontinuous wavy laminae serves to differentiate the Hoskinnini member from the underlying and overlying strata. These features also make possible the correlation of the member with rocks not previously correlated with the Hoskinnini in southeastern Utah and adjoining parts of Colorado. --Auth.

1-2247. Elliott, Robert Howard J. SUB-SURFACE CORRELATION OF THE EDMONTON FORMATION: Edmonton Geol. Soc., Quart., v. 2, no. 2, p. 1-8, 12 figs., June 1958, pub. Dec. 1958, 4 refs.

Interest in the Edmonton formation [Upper Cretaceous] has decreased markedly in the past 10 years because of lack of 1) commercial importance and 2) stratigraphic markers traceable with E'Logs. The first geologic marker on a well log may be the "First White Specks" at 5,000 ft., indicating a distinct lack of geologic curiosity concerning the upper 1/2-1/3 of the sediments in the deeper part of the Alberta basin. It is hoped that presentation of some subsurface correlations from the foothills to the plains outcrops will stimulate interest in this part of the section. --R. S. Taylor.

1-2248. Mallory, V. Standish. LOWER TERTIARY BIOSTRATIGRAPHY OF THE CALIFORNIA COAST RANGES: 416 p., 7 figs. (1 in pocket), 42 pls., 19 tables (6 in pocket), Tulsa, Oklahoma, American Association of Petroleum Geologists, 1959, approx. 340 refs.

A synthesis which figures and describes the majority of important foraminiferal species and shows by means of check lists their stratigraphic occurrences in many localities and determines their range in the strata. A standard chronologic-biostratigraphic sequence consisting of 2 Paleocene (the Ynezian and Bulitian) and 3 Eocene stages (the Penutian, Ulatisian, and Narizian), each with 2 zones, is proposed.

A critical summary and evaluation of earlier geological investigations covers 4 categories of works: 1) the geological, contributing primarily to the recognition and stratigraphical nomenclature of Paleogene units, 2) chronological classifications based on larger invertebrates, 3) micropaleontological investigations, and 4) micropaleontological chronological classifications.

Criteria for the recognition of the stages and zones by means of the overlap in range of certain jointly occurring species are given. The faunal, ecological, stratigraphical, and distributional aspects of these subdivisions of the lower Tertiary are demonstrated. Text figures show the major basins of marine Paleogene deposition, the location of key stratigraphic sections discussed, and sketch geologic maps of the type areas of the stages and zones.

Chapters discussing the important larger invertebrate and vertebrate faunas in their relationship to foraminiferal faunas are followed by an examination of the age of the California stages and zones with respect to European and to other foreign entities, and a final summation in a large correlation chart.

Approximately 2000 different species of Foraminifera are discussed; some of the illustrated species are recognized for the first time from the west coast. Fifty-seven species and varieties are described. --Auth.

1-2249. Kitts, David B. CENOZOIC GEOLOGY OF NORTHERN ROGER MILLS COUNTY, OKLAHOMA: Oklahoma Geol. Survey, Circ. 48, p. 1-26, 2 maps (geol. map scale 1 in. to approx. 1 1/3 mi., in pocket), diag., 1959, 14 refs.

The Cenozoic geology of that part of Roger Mills County N. of the S. line of T. 15 N. is considered.

The Pliocene Ogallala group, about 300 ft. thick in this area, consists predominantly of fine- to medium-grained quartz sands. This group rests unconformably on the Permian Quartermaster and Cloud Chief formations. In this area the age of the Ogallala group ranges from middle Clarendonian to middle Hemphillian. Bordering the South Canadian River is a succession of 3 erosional and 3 depositional terraces. The high terrace deposits which are 80 ft. thick are probably Kansan in age. The intermediate terrace deposits which are 50 ft. thick may be Illinoian in age. The low terrace deposits which are 60 ft. thick are probably Wisconsinan in age.

During early Cenozoic time there was little or no deposition in the area. Early in Pliocene time the rivers began to aggrade, and before the end of Hemphillian time over 300 ft. of channel and flood-plain sediments had been deposited. Late in Pliocene or early in Pleistocene time an E.-W.-trending channel was eroded through the Ogallala sediments, and later this channel was filled with gravel. In middle and late Pleistocene time the South Canadian River underwent 3 cycles of erosion and deposition which resulted in a succession of erosional and depositional terraces. --Auth.

5. PALEONTOLOGY

See also: Stratigraphy 1-2248, 1-2261.

1-2250. Strimple, Harrell L. CRINOID FROM THE MISSOURIAN NEAR BARTLESVILLE, OKLAHOMA: Oklahoma Geology Notes, v. 19, no. 6, p. 115-127, 2 figs., 2 pls., June 1959, 3 refs.

Revised republication of privately printed paper of 1938. Descriptions of 5 new species and of 2 identified species from the 1938 paper are revised. Three species are reassigned and figures of the cup of Synbathocrinus melba are given. Descriptions of the localities are expanded, and type numbers are supplied. --C. C. Branson.

1-2251. Cooke, C. Wythe. CENOZOIC ECHINOIDS OF EASTERN UNITED STATES: U. S. Geol. Survey, Prof. Paper 321, 106 p., 43 pls., July 1959, 195 refs.

This work describes 144 species or subspecies of echinoids from the Atlantic and Gulf Coastal Plain of the United States and from the adjacent waters. Eighteen species are restricted to the Vincentown sand of New Jersey, the Salt Mountain limestone of Alabama, or the Midway group of Alabama, all of Paleocene age. The Bashi formation of Alabama, of early Eocene age, includes 1 species. The middle and late Eocene formations of the Carolinas, Alabama, Mississippi, and Texas have 27 species. The late Eocene, with 43 species, has the most varied echinoid fauna; most of the species occur in the Ocala limestone or in the Inglis limestone, the Floridian equivalent of the Moodys Branch marl of Mississippi. The Oligocene faunas include only 13 species, 1 in the early Oligocene, 3 in the middle, and 11 in the late Oligocene; the middle and late have 2 species in common. Of 18 Miocene species, 3 were obtained from the early Miocene, 15 from the late Miocene. One specimen is doubtfully referred to the Pliocene. Of 21 species of Recent echinoids, several have been found fossil in Pleistocene beds, and 1 possibly extends back to the late Miocene. Echinoids are exceptionally good horizon markers because of their short geologic ranges.

The species fall into 60 genera and 4 subgenera, of which the following 3 genera are new: Rhopostoma, type species Ananchytes cruciferus Morton; Santeelampas, type species Catopygus oviformis Conrad; Unifascia, type species Macropneustes carolinensis Clark. The new family Unifasciidae is proposed to receive Unifascia. The type species of all the genera are designated and briefly described. New species are: Tylocidaris? salina, Tylocidaris macneili, Fibularia alabamensis, Neolaganum durhami, Hemiaster moscovensis, Lovenia alabamensis, Spatangus glenni, Brissus glenni.

Transfers of species to different genera or subgenera include: Cidaris walcotti Clark to Tylocidaris; Cidaris diatretum Morton to Echinopsis; Psammechinus floralanus Cooke to Lytechinus; Thylechinus (Gagaria) salis Cooke to Gagaria; Thylechinus (Gagaria) mossomi Cooke to Gagaria; Thylechinus (Gagaria) chickasawhay Cooke to Gagaria; Orthechinus pretiosus Clark to Brochopleurus; Cyphosoma speciosum Clark to Gauthieria; Ananchytes cruciferus Morton to Rhoposoma, new genus; Laganum dalli Twitchell to Neolaganum; Peronella cubae Weisbord to Weisbordella; Laganum johnsoni Twitchell to Weisbordella; Catopygus conradi Conrad to Cassidulus (Plagiopygus); Cassidulus (Pygorhynchus) carolinensis Twitchell to Cassidulus (Plagiopygus); Nucleolites lyelli Conrad to Cassidulus (Plagiopygus); Cassidulus (Pygorhynchus) georgiensis Twitchell to Cassidulus (Plagiopygus); Cassidulus (Paralampas) globosus Fischer to Cassidulus (Plagiopygus); Catopygus oviformis Conrad to Santeelampas, new genus; Cassidulus (Rhynchopygus?) holmesi Twitchell to Eurhodia (Gisopygus); Eupatagus? (Brissopatagus?) primus Cooke to Linthia?; Schizaster armiger Clark to Paraster; Schizaster americana Clark to Paraster; Schizaster (Linthia) ocalanus Cooke to Schizaster (Brachybrissus); Schizaster beckeri Cooke to Ditremaster; Macropneustes carolinensis Clark to Unifascia, new genus; Hemipatagus argutus Clark to Maretia; Hemipatagus subrostratus Clark to Maretia; Spatangus ventricosus Lamarck to Macropneustes; Eupatagus (Plagiobrissus) dixie Cooke to Plagiobrissus?; Plagionotus holmesii McCrady to Plagiobrissus?; Eupatagus (Plagiobrissus) curvus Cooke to Plagiobrissus; Euspatangus antillarum Cotteau to Eupatagus (Gymnopatagus); Eupatagus (Plagiobrissus) gardnerae Cooke to Eupatagus (Gymnopatagus); Eupatagus carolinensis Clark to Eupatagus (Gymnopatagus); Eupatagus (Plagiobrissus) ocalanus Cooke to Eupatagus (Gymnopatagus).

A glossary and a bibliography are included. --Auth.

1-2252. Ross, Reuben James, Jr. BRACHIOPOD FAUNA OF SATURDAY MOUNTAIN FORMATION, SOUTHERN LEMHI RANGE, IDAHO: U. S. Geol. Survey, Prof. Paper 294-L, p. 441-461, map, 9 diags., 3 pls., 2 tables, July 1959, 40 refs.

Silicified brachiopods occur in the Saturday Mountain formation of the southern Lemhi Range, Idaho, in great numbers, but not in great variety. Nineteen species have been identified. Poor sorting by size or shape of shells at most localities suggests accumulation under quiet bottom condition. Austinella and the new genus Lordorthis are the most abundantly represented genera. Most of the fauna shows affinities with Late Ordovician species, but Middle Ordovician elements are present. --Auth.

1-2253. Branson, Carl C., Maxim K. Elias, and Thomas W. Amsden. TYPE OF GONIATITES CHOCTAWENSIS: Oklahoma Geology Notes, v. 19, no. 8, p. 157-164, map, 6 illus., Aug. 1959, 16 refs.

The type locality in Oklahoma of Goniatites choctawensis Shumard, 1863, is relocated, and a specimen from the locality is designated neoholotype to replace the holotype, which was destroyed by fire. A measured section at the locality is given. The suture, the external ornamentation, and lateral and ventral aspects of the shell are figured. --C. C. Branson.

1-2254. Kitts, David B., and Craig C. Black. A PLIOCENE VERTEBRATE LOCAL FAUNA FROM ROGER MILLS COUNTY, OKLAHOMA: Oklahoma Geol. Survey, Circ. 48, p. 27-47, 9 figs. incl. map, columnar sec., pl., 4 tables, 1959, 12 refs.

A vertebrate fauna from the Ogallala group is described. The Durham locality is 2 1/2 mi. NW. of the town of Durham, in the SE1/4 sec. 15, T. 16 N., R. 26 W. The specimens were recovered from a buff sand layer 6 ft. thick and from an overlying cross-bedded sand layer 11 ft. thick. The

fauna includes Testudo sp., Coluber (?), Mylagaulus cf. M. laevis, Perognathus cf. P. pearlettensis, Vulpes sp., Mephitinae gen. and sp. indet., Nannippus cf. N. gratus, Neohipparion sp., Merycoidodontidae gen. and sp. indet., Megatylopus sp., and Antilocapridae gen. and sp. indet. The Durham local fauna is Clarendonian in age, probably middle Clarendonian. --Auth.

1-2255. Kitts, David B., and Arthur J. Myers. A PLIOCENE BADGER, PLIOTAXIDEA NEVADENSIS (BUTTERWORTH) FROM HARPER COUNTY, OKLAHOMA: Oklahoma Geology Notes, v. 19, no. 7, p. 143-146, 2 illus., chart, table, July 1959, 3 refs.

In 1955, a nearly complete right mandible with M_1 and M_2 and the roots of P_2, P_3, and P_4 of a Pliocene badger, Pliotaxidea nevadensis (Butterworth) was found weathered from the Ogallala formation. The location of the find is the Raymond Bently ranch in Harper County, Oklahoma. --M. Russell.

1-2256. Graham, Richard. ADDITIONS TO THE PLEISTOCENE FAUNA OF SAMWEL CAVE, CALIFORNIA. I. CANIS LUPUS AND CANIS LATRANS: Cave Studies, no. 10, p. 54-67, 7 illus., fold. secs., Apr. 1959, 10 refs.

The Pleistocene timber wolf Canis lupus and the Pleistocene coyote Canis latrans were not previously reported in the fossil discoveries of Samwel Cave, Shasta County, California. Reexamination of the site, in which the University of California made an extensive collection about 50 years ago, revealed a fossil deposit which remained undisturbed. This deposit is now being excavated and thus far has yielded many Pleistocene fossils, of which several should be included in the faunal list from this cave.

Both the wolf and coyote skulls are compared with other Quaternary canids from California. Comparative illustrations drawn to exact scale are included, along with measurements. A map of one portion of the cave is also given.

The timber wolf is of special interest since the species is now extinct in California and since Pleistocene timber wolves are also rare. The specimen closely resembles the large races of timber wolves now resident in northern Canada and Alaska. --Auth.

1-2257. Carrington, Richard. ELEPHANTS: 272 p., 79 illus., map, 3 charts, New York, Basic Books, Inc., 1959, approx. 200 refs.

This is a popular book, fairly detailed in respect to the elephant's habits and evolution, but more general in regard to its structure. The elephants are now represented by 2 genera, Loxodonta in Africa and Elephas in Asia. They occupy a wide range of environments, from mountain rain forest through high temperate plateaus to humid coastal plains. Wild elephants feed for at least 16 hours a day, far more than in captivity. The elephant is not exceptionally intelligent but, as the old tale truly maintains, it has an excellent memory. Its living relatives are the Hyrax and the Sirenia. The order Proboscidea is divided into 3 suborders: Moeritherioidea, containing the single genus Moeritherium (Eocene-Oligocene); Dinotherioidea with the single genus Dinotherium (Miocene-Pleistocene); and Elephantoidea, with 3 subfamilies (Gomphotheriidae, Oligocene-Pleistocene; Mastodontidae, Oligocene-Pleistocene; and Elephantidae, Pliocene-Recent).

Elephants have been domesticated since the second millenium B. C. Elephas is more commonly domesticated, but Loxodonta has been successfully trained in the Belgian Congo. Elephants were first exhibited in a zoo in Syria in the 9th century B. C. They were used in war from earliest times until the invention of firearms, and for labor until the present, especially in India, Ceylon, and Burma. Ivory poaching caused a great decrease in numbers through the 19th century, but modern control laws have resulted in considerable increase in recent years. --F. C. Whitmore, Jr.

1-2258. Todd, Ruth. RECENT LITERATURE ON THE FORAMINIFERA: Cushman Found. Foraminiferal Research, Contr., v. 10, pt. 3, p. 106-110, July 1959.

Eighty-five briefly annotated references are given, arranged alphabetically by author. References are world-wide and are mostly from the period 1958-1959. --L. M. Dane.

1-2259. Toomey, Donald F. ANNOTATED BIBLIOGRAPHY OF LATE PALEOZOIC NONFUSULIND FORAMINIFERA: Cushman Found. Foraminiferal Research, Contr., v. 10, pt. 3, p. 71-105, graph, July 1959; also pub. as: Shell Devel. Co., Explor. & Production Research Div., Pub. no. 202.

This annotated bibliography includes 233 references pertaining to late Paleozoic nonfusulinid Foraminifera, and may be considered reasonably complete through the year 1957, inclusive. The bibliography covers 3 distinct aims: 1) to summarize briefly the contents of each article, 2) to list all new genera and species described therein, and 3) to include, in brackets, all taxonomic changes noted from later publications, thus making the bibliography a useful working tool for specialists. --Auth.

1-2260. Elias, Maxim K. FUSULINID GENERA PROTRITICITES, PSEUDOTRITICITES, AND PUTRELLA: Oklahoma Geology Notes, v. 19, no. 8, p. 165-178, 17 illus., 4 tables, Aug. 1959, 12 refs.

The original descriptions of the genera Protriticites, Pseudotriticites, and Putrella and of the genotype species are translated from the Russian. Subsequent revisions of Rauser-Chernousova and of Putrja are also translated, and comments are made on the taxonomy and stratigraphy. --C. C. Branson.

1-2261. Branson, Carl C. A STRATIGRAPHIC LEAK: Oklahoma Geology Notes, v. 19, no. 7, p. 138-140, July 1959, 11 refs.

The reported occurrence of Globigerina seminolensis Harlton, presumably a Cretaceous foraminifer, from an outcrop of Pennsylvanian age in the Criner Hills appears to be an unusually complicated case of a stratigraphic leak. The foraminifer was designated the holotype of a new genus, Hedbergella, by Brönnimann and Brown, and the need for clarifying its original locality and stratigraphic position is considerable. --M. Russell.

1-2262. Cole, W. Storrs. FAUNAL ASSOCIATIONS AND THE STRATIGRAPHIC POSITION OF CERTAIN AMERICAN PALEOCENE AND EOCENE LARGER FORAMINIFERA: Bulls. Am. Paleontology, v. 39,

no. 182, p. 377-393, 22 illus. on 2 pls., fold. table, July 1959, 23 refs.

Two larger foraminiferal faunas, the Operculina catenula fauna of supposed upper Paleocene age, and, the Pseudophragmina (Proporocyclina) tobleri fauna of probable middle Eocene age, are discussed and analyzed. Certain species in these faunas are illustrated. General remarks are given on the American species of Discocyclina (Discocyclina) and their stratigraphic range. --Auth.

1-2263. Sachs, K. N., Jr. PUERTO RICAN UPPER OLIGOCENE LARGER FORAMINIFERA: Bulls. Am. Paleontology, v. 39, no. 183, p. 399-416, 31 illus. on 3 pls., 2 tables, July 1959, 20 refs.

Nine species of larger Foraminifera from 2 localities from the San Sebastian formation of upper Oligocene age of Puerto Rico are discussed and illustrated. This fauna is similar to one described from the upper Oligocene part of the Caimito formation of Barro Colorado Island, Panama Canal Zone, and others from Texas, Cuba, and Trinidad. The intergradation of Heterostegina israelskyi with H. antillea is discussed, and a revised key to American Eocene and Oligocene heterosteginids is given. --Auth.

1-2264. Ellis, Brooks F., and Angelina R. Messina. CATALOGUE OF OSTRACODA, VOLUME 12: [680] p., illus., New York, The American Museum of Natural History, 1959, 40 refs.

The twelfth volume of the Catalogue of Ostracoda contains 453 units, of which 26 represent genera or subgenera, and 427 represent species or subspecies (varieties). All but 8 of the latter group are illustrated. The units that are not illustrated include 3 varieties that apparently have never been illustrated, and 5 new names for previously illustrated species. The species described by Sutton and Williams under the names Cythereis? elongata and Pyricythereis smithvillensis carry footnotes to indicate that they are homonyms. The units with the new names will appear in volume 13.

The majority of forms included in this volume are from the Tertiary. This change in emphasis was made to meet the demand for more extensive post-Paleozoic coverage. The distribution of the forms in the present volume is as follows: Paleozoic (Ordovician and Pennsylvanian) 8; Jurassic 13; Cretaceous 25; and Tertiary 407. --Auth.

6. GEOPHYSICS

See also: Areal and Regional Geology 1-2195,1-2196.

1-2265. Heinrichs, Walter E., Jr. TRENDS IN THE APPLICATION OF GEOPHYSICS: Mining Engineering, v. 11, no. 7, p. 688-690, illus., July 1959.

A resume of the actual situation of geophysics in mining - where, how, for what purposes, and at what costs - based on the current picture of exploration in Arizona. Since World War II exploration geophysics has derived its scope from the following factors: 1) the usual post-war interest in exploration to rebuild war-depleted reserves; 2) the impetus supplied by the U prospecting boom; 3) increased demand for natural resources due to the Korean War; 4) the discovery of substantial metallic ore by geophysical means in Canada, the U. S., and other countries; and 5) continuing discoveries of commercial oil by geophysical methods throughout the world. --Auth.

1-2266. Fajklewicz, Zbigniew. THE USE OF CRACOVIAN COMPUTATION IN ESTIMATING THE REGIONAL GRAVITY: Geophysics, v. 24, no. 3, p. 465-478, 6 maps, graph, 6 tables, July 1959, 6 refs.

The author uses the method of least squares in cracovian form and second order polynomials for estimating the regional gravity field. Expressions yielding the regional field are obtained very rapidly by using the inverse cracovians of the coefficients as given in the present paper, and there is no need of electronic digital computers for the computation. The equivalent of the entire work done by a computer of this kind in constructing the formula of the regional field, when effected by this method, takes no more than 20 minutes. The method is exemplified by the treatment of 2 gravity anomalies from the territory of Poland. The author stresses the fact that electronic computers adapted to the use of cracovians and characterized by a very high versatility may be applied in the method. --Auth.

1-2267. Lundberg, Hans T., and John H. Ratcliffe. AIRBORNE GRAVITY METER, DESCRIPTION AND PRELIMINARY RESULTS: Mining Engineering, v. 11, no. 8, p. 817-820, 5 figs. incl. map, diag., Aug. 1959, 2 refs.

In airborne gravity surveys effects of acceleration and irregular movements of the aircraft must be balanced out or overcome. The gradient of vertical gravity is recorded, therefore, by using 2 masses instead of one. General principles are outlined and theoretical considerations explored in the paper. Instrumental details, tests, and trials are enumerated before final interpretation, conclusions, and a look at future developments. --Auth.

1-2268. Vajk, Raoul, and N. Van Der Sleen. STANDARDIZATION OF GRAVITY SURVEY PROCEDURES: Geophysics, v. 24, no. 3, p. 479-484, sec., July 1959, 4 refs.

Standardization of gravity datum, gravity meter calibration, latitude correction, elevation datum, average density correction factor, map scale and grid, and gravity bench mark information between companies working in the same area prior to execution of the surveys is recommended to facilitate future trades of information. Governmental agencies, geodesists, and earth scientists will also benefit by such standardization. --Auth.

1-2269. GEOMAGNETIC EFFECTS OF NUCLEAR EXPLOSIONS: U. S. Natl. Bur. Standards, Tech. News Bull., v. 43, no. 7, p. 121-122, fig., July 1959.

In Aug. 1958 the United States fired 2 nuclear

bombs at high altitudes from Johnston Island in the Pacific. Analysis of changes in the earth's magnetic field indicate that "these nighttime explosions ionized the upper atmosphere at a distance of 2,000 km. to nearly daytime intensity, resulting in electric current flows that temporarily altered the geomagnetic field." --L. M. Dane.

1-2270. McEuen, Robert B., Joseph W. Berg, Jr., and Kenneth L. Cook. ELECTRICAL PROPERTIES OF SYNTHETIC METALLIFEROUS ORE: Geophysics, v. 24, no. 3, p. 510-530, 2 diags., 12 graphs, July 1959, 26 refs.

Ninety small cores of synthetic metalliferous ore were constructed from solid glass spheres averaging 0.5 mm. in diameter, Pb spheres 1.0 mm. in diameter, and refractory cement. The Pb content of the cores varied from zero to 50% by frame volume. The effective porosity was controlled by the manufacturing pressure and ranged from 10 to 20%. The cores were saturated with NaCl solution. The apparent impedance of the cores was measured with a modified Wheatstone bridge as a function of frequency and current density. The low-frequency effects of induced polarization were separated from the over-all decrease of impedance with increase of frequency by taking advantage of the dependence of these effects upon current density. The over-all decrease of the impedance with frequency and the polarization effects were found dependent upon the effective porosity and the Pb content. Both the polarization effects and the over-all decrease of the impedance with frequency increased with decreasing porosity. The induced polarization effects at 10 c.p.s. attained a maximum at approximately 15% Pb content. The impedance of a synthetic ore with a small Pb content was found to be larger than that of corresponding cores barren of Pb. --Auth.

1-2271. de Witte, Leendert, and Roy W. Gould. POTENTIAL DISTRIBUTION DUE TO A CYLINDRICAL ELECTRODE MOUNTED ON AN INSULATING PROBE: Geophysics, v. 24, no. 3, p. 566-579, 4 diags., 5 tables, July 1959, 7 refs.

The potentials around a finite cylindrical electrode can be obtained by dividing the electrodes into rings of equal thickness and substituting an infinitely thin current ring for each of the slices. The field of an infinitely thin ring electrode mounted on an insulating cylindrical probe of the same diameter can be found by combining the properties of the delta function with a solution of Laplace's equation in cylindrical coordinates. Combination of solutions for the infinitely thin rings under the condition that the potential of the electrode surface be constant leads to a system of simultaneous linear equations. By increasing the number of slices, the potential around the finite electrode can be found arbitrarily close.

The problem of a cylindrical electrode on a sonde located coaxially in a conducting hole, drilled through a medium of different conductivity, is treated by the same method. This arrangement is of interest in electrical logging of drill holes.

Numerical examples have been calculated on an IBM 650 magnetic drum computer. The potential along the surface of the insulating probe, at distances larger than twice the electrode length, can be approximated with good accuracy by assuming that all of the current is emitted from an infinitely thin ring located in the median plane of the electrode. --Auth.

1-2272. Seigel, Harold O. MATHEMATICAL FORMULATION AND TYPE CURVES FOR INDUCED POLARIZATION: Geophysics, v. 24, no. 3, p. 547-565, 12 figs. incl. 4 diags., 6 graphs, July 1959, 12 refs.

A basic mathematical formulation is developed for overvoltage and other induced polarization phenomena. Starting from the fundamental representation of a volume dipolar distribution, one is led to the concept of a change in apparent conductivity due to polarization effects. The mathematical solution of induced polarization phenomena, therefore, reduces to the appropriate solution of Laplace's equation for the same geometry and conductivity distribution ignoring polarization, followed by partial differentiation of the apparent resistivity function so determined. The dielectric constants of the media are not involved in the solution.

As examples of the use of the representation, the response of a polarizable sphere and of a polarizable lower layer in a typical 2-layer case are presented. Actual field results are shown illustrating the use of the latter solution. --Auth.

1-2273. Ward, Stanley H. UNIQUE DETERMINATION OF CONDUCTIVITY, SUSCEPTIBILITY, SIZE, AND DEPTH IN MULTIFREQUENCY ELECTROMAGNETIC EXPLORATION: Geophysics, v. 24, no. 3, p. 531-546, 2 diags., 10 graphs, July 1959, 11 refs.

The response of a conductive, magnetic sphere in a uniform, alternating magnetic field is a function of the conductivity, permeability, and radius of the sphere and of the frequency of the alternations. Over one range of frequencies, eddy-current density in any given sphere and secondary magnetic fields of the sphere are relatively constant and high. Over a much lower range of frequencies eddy currents are negligible, but the secondary magnetic fields may be of large constant amplitude but of polarity reversed to that of the higher frequency range. At some intermediate frequency the secondary magnetic fields will be entirely quadrature with respect to the inducing field.

Utilization of this peculiar frequency dependence and of the geometry of the secondary magnetic fields permits unique determination of the conductivity, permeability, radius, and depth to the center of a buried sphere. The procedure for obtaining these variables is described in this article.

As an added feature, it is shown that by completing a gravity survey as well as an electromagnetic survey over a dense, magnetic, conductive spherical ore body, it is possible to determine the above variables, plus density, uniquely. Precise identification of the material of the sphere is seen as a possible result of the application of this technique. --Auth.

1-2274. Roman, Irwin. AN IMAGE ANALYSIS OF MULTIPLE-LAYER RESISTIVITY PROBLEMS: Geophysics, v. 24, no. 3, p. 485-509, 2 figs., 2 tables, July 1959, 8 refs.

The Kelvin method of images is expressible by a transflection at a boundary. The original source is augmented by a supplement and a complement. The supplement contributes to the potential on the same side of the boundary as the source, but it lies at the optical image position of the source in the boundary. The complement lies at the position of the source but

contributes to the potential on the opposite side of the boundary.

For 2 or more boundaries, there are 2 exterior regions and one or more interior regions. For a source in the top layer, a primary sequence starts with a downward transflection and a secondary sequence with an upward transflection. To each primary sequence of transflections there corresponds a secondary sequence with an upward transflection at the upper boundary ahead of it. The exterior images are not transflected again. Successive transflections occur at adjacent boundaries, suggesting a link of 2 transflections. To a sequence of links, called a chain, there corresponds an associated sequence, obtained by dropping the last transflection. Exterior images follow from interior, associated from chain, and secondary from primary. Thus, only primary, interior, chain images need to be traced.

Each potential is the sum of terms of the form m/r where m is the strength of a specific image, r is the distance of that image from the test point, and the sum includes all images contributing to that potential. The addition of each boundary introduces images and potentials that must be added to those existing prior to the introduction, but it does not otherwise alter them.

For the 3-boundary problem, the separate image strengths are determined by simple multiplication after a kernel polynomial is calculated. The latter is a finite polynomial in the reflection-factor at the middle boundary and can be tabulated. For the images of a specific potential and depth group, the strengths satisfy a recursion formula that serves as a check on direct evaluations. --Auth.

1-2275. Slotnick, Morris Miller. LESSONS IN SEISMIC COMPUTING; A MEMORIAL TO THE AUTHOR. Edited by Richard A. Geyer: 268 p., port., 124 figs. incl. diags., graphs, approx. 14 tables, [Menasha, Wisconsin], Society of Exploration Geophysicists, 1959.

The theory behind modern techniques of seismic surveying is presented in 44 lessons with the purpose of furnishing the seismic computer with a broad understanding of seismic paths, the properties of which form the basis of most of the necessary numerical calculations. The lessons cover in detail the mathematical analyses of the concepts considered. Lessons are included of the following subjects condensed from the table of contents:

- Emergence angles
- Time-distance plots
- Elementary concepts and analytical treatment of the seismic reflection problem
- Time-depth charts
- Velocity determination from reflection data
- Reflections from a dipping interface
- Determination of velocity and interface from reflection data
- Elements of "dip-shooting"
- Plotting reflection points on dipping reflecting horizons
- Snell's Law, principle of least time
- Single-layer reflection and refraction paths
- The two-layer horizontal refraction problem
- Single dipping interface refraction profile
- Analytical basis of the elementary refraction problem
- Corrections for seismic data
- The three-dimensional seismic path problem, single-layer
- Reflection from a single dipping interface, concepts, analyses and applications
- The multilayered problem
- Parametric form of the time-distance reflection curve
- The two-layer reflection time-distance curve
- Extension to the multi-layered problem, average velocities
- The theory of curved paths
- Linear distribution of velocity, the refraction time-distance curve, the refraction problem, the wave fronts, well shooting theory and practice, the reflection problem
- The relation between offset and Δt in reflection shooting

The lessons are arranged for classroom use, and practice problems are outlined for the student to solve. --M. Russell.

1-2276. Benioff, Hugo. FUSED-QUARTZ EXTENSOMETER FOR SECULAR, TIDAL, AND SEISMIC STRAINS: Geol. Soc. America, Bull., v. 70, no. 8, p. 1019-1032, 15 figs. incl. 9 diags., 2 graphs, Aug. 1959, 2 refs.

A description is given of 2 fused-quartz extensometers located in mountain tunnels at Dalton Canyon and Isabella in southern California and designed for observing long-period seismic-wave strains, earth tidal strains, and secular strains. They consist essentially of instruments for measuring and recording variations in the separation of 2 piers by comparison with a length standard of fused-quartz tubing. The sensitivity for secular strains, defined as the least detectable strain increment, is approximately 10^{-7}. For tidal and seismic-wave strains, the sensitivity is higher - a 1-mm. deflection of the recorder represents a strain increment of 5.2×10^{-10}. In both cases the maximum usable sensitivity is limited by ground-strain unrest or noise, generated by wind, barometric-pressure variations, temperature variations of the surface layers of the ground, and variations in ground-water saturation. --Auth.

1-2277. Hicks, Warren G. LATERAL VELOCITY VARIATIONS NEAR BOREHOLES: Geophysics, v. 24, no. 3, p. 451-464, 8 figs. incl. 4 graphs, 2 logs, diag., July 1959, 6 refs.

Difficulties occur in obtaining accurate 2-receiver velocity logs in formations sensitive either to damage by exposure to drilling mud or to mechanical stress relief. Some shales are so altered by the drilling operation that their elastic properties are modified. Vertical velocity measured immediately adjacent the boreface is lower than if it were measured at a greater radial distance from the bore. These damaged shales require relatively deep penetration by the acoustic signal; consequently, the transmitter-to-first-receiver spacing in a 2-receiver velocity logging system should be long enough to refract the sound waves through virgin formation. Experiments in one predominantly shaly section show a difference of almost 10% between times measured using transmitter-to-first-receiver spacing of 4.3 ft. compared to 8.8 ft. A limited amount of field data suggest that sodium montmorillonite is the clay type most sensitive to hydration and swelling. Studies of areal prevalence of the shale damage problem are incomplete. --Auth.

Discussions by J. A. Brooks and F. Kaarsberg are included, with a reply by the author.

1-2278. SEISMIC ANALYSIS AIDS IN OVERBURDEN REMOVAL: Mining Engineering, v. 11, no. 8, p. 803-804, illus., sec., 2 graphs, Aug. 1959.

The mine engineer or operator can determine easily, quickly, and inexpensively when to drill and blast and when to rip overburden for lower costs. By using seismic analysis he can put the right equipment to work for top job efficiency. The method involves use of a refraction seismograph which measures over-all consolidation of subsurface materials, including such factors as rock hardness, stratification or lamination, fracturing or jointing, and the degree of weathering or decomposition. The success of numerous seismic analyses conducted by the engineers indicates that expensive and complicated methods of classifying materials for overburden removal are no longer necessary. --Auth.

1-2279. Blundun, G. J. THE MISSISSIPPIAN IN THE ALBERTA PLAINS AND THE REFLECTION SEISMOGRAPH: Geophysics, v. 24, no. 3, p. 426-442, 12 figs. incl. map, sec., geol. column, July 1959.

The eroded Mississippian surface is the major unconformity in the province of Alberta. To map its erosional highs and lows is most important, because the Mississippian may be productive of hydrocarbons or may cloak the attitude of deeper sediments from which production is sought. This paper deals with the methods of presentation of reflection seismic data to that end, together with a suggested recording instrument technique. Some of the interpretive problems, and the possible significance of Mississippian porosity on the acoustic impedance of its reflection are mentioned.

Maps of similar data, one geological and the other reflection seismic, are presented for comparison. The former is obtained from drilled wells and the latter from reflection shooting performed prior to drilling. --Auth.

1-2280. Widess, M. B., and Garvin L. Taylor. SEISMIC REFLECTIONS FROM LAYERING WITHIN THE PRECAMBRIAN BASEMENT COMPLEX, OKLAHOMA: Geophysics, v. 24, no. 3, p. 417-425, 5 figs. incl. illus., map, sec., July 1959, 2 refs.

Reflections from within the Precambrian basement complex were recorded in the vicinity of the Wichita Mountains in southwestern Oklahoma. The reflections, of good quality and persistence, depict a section in excess of 20,000 ft. of igneous rocks that appears like a seismic section of sedimentary formations.

A well in the area drilled 4,000 ft. of this Precambrian section, encountering alternating layers of silicic and gabbroic igneous rocks exhibiting high contrast in density. Precambrian outcrops of much of the Wichita Mountains, comprising comparable types of rocks, display sheetlike, gently dipping layers, some of which persist for several miles. The seismic reflections are thus produced by the igneous layers of differential acoustic properties. An abrupt change of direction of dip occurring at about mid-depth of the seismic section precludes the possibility that the seismic events are multiple reflections. --Auth.

1-2281. Wood, A. B. A COMPARISON OF WELL VELOCITY METHODS IN SOUTH TEXAS: Geophysics, v. 24, no. 3, p. 443-450, 3 diags., 2 graphs, July 1959.

This velocity study is limited to data from one well in south Texas. Two short-interval velocity logging methods compared with conventional seismic geophone data show large discrepancies. The Shell short-interval velocity log agrees within close limits to the conventional seismic data except for the lower 4,000 ft. The indicated delay times for the upper 2,000 ft. of this 4,000-ft. interval are short by 6.5%, and indicated delay times for the lower 2,000 ft. are short by 4.0%. The Schlumberger sonic velocity log, limited in this survey to the bottom 4,200 ft. of hole, indicated delay times larger than the seismic time by more than 5%. There is a difference of approximately 9% between the 2 velocity logs, even though the tools were of similar dimensions. The spacing between detectors was 3 ft., and the distance from transmitter to near receiver was 4 ft. for the Shell tool and 3 ft. for the Schlumberger tool.

An analysis of the basic data is necessary to resolve these discrepancies. There is no check on the sonic data in its present form, but a thorough study of the Shell oscillogram log and conventional seismic data for errors fails to explain the 6.5% and 4% discrepancies in the Shell short-interval velocity data. The conclusion must be drawn that these discrepancies are real. This survey demonstrates the necessity to check short-interval velocity logging with conventional seismic shots to maintain acceptable seismic well velocity standards. --Auth.

1-2282. Higgins, G. E. SEISMIC VELOCITY DATA FROM TRINIDAD, B.W.I., AND COMPARISON WITH THE CARIBBEAN AREA: Geophysics, v. 24, no. 3, p. 580-597, 9 figs. incl. map, 2 graphs, 4 logs, July 1959, 7 refs.

The results of the velocity surveys made on 4 deep ($\pm$10,000 ft.) wells in Trinidad are reported, together with summaries of the lithologic and stratigraphic data recorded by the wells. An unusual velocity inversion of 5,000 ft./sec. between 2,500- and 5,000-ft. depth is reported in one well, Moruga 15. The recorded data from the well surveys and from refraction surveys shot near the metamorphosed northern ranges in Trinidad are compared with published data reported by Worzel, Ewing, et al. in their refraction surveys within the Caribbean Sea, the Venezuelan waters near Trinidad, and Barbados. Comparison is also made with the results of refraction surveys in British and Dutch Guiana. --Auth.

1-2283. Breyer, Friedrich. ATTEMPTS AT GEOLOGICAL INTERPRETATION OF REFLECTION-SEISMIC MEASUREMENTS IN THE FOLDED MOLASSE OF BAVARIA: Internat. Geology Rev., v. 1, no. 6, p. 1-10, 5 figs. incl. map, June 1959, 11 refs.

The reflection-seismic survey in the folded molasse of Bavaria indicated that molasse fold structure is not as simple as it would appear from surface outcrops or as the structures farther S. at the alpine margin. It was determined that the sequence of structural elements from W. to E. is 1) a cross swell, 2) a SW.-striking fault causing irregularities in the apparently regular Murnau basin, 3) inferred faulting in an area covered with Quaternary sediment, and 4) NE.-striking, deep-seated structures at the E. end of the Murnau basin. The complexity of the structure of the folded molasse in this region indicates that this area experienced diastrophism of alpine magnitude before late Neogene folding. --Ed. abs.

1-2284. Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. METHODS AND CASE HISTORIES IN MINING GEOPHYSICS: 359 p., illus., maps (12 in pocket), secs., graphs, tables, Montreal, Mercury Press Company, [1959?]) refs.

This volume is intended to provide the delegates who attended the Sixth Commonwealth Mining and Metallurgical Congress, Montreal, 1957, with a study of some of the exploratory work of the geophysicist related to development in several Canadian mining districts visited during the Congress tour. Examples of geophysical surveys have also been taken from other countries of the Commonwealth. The book is planned principally for readers who are not geophysicists, but are the mining engineers, geologists and civil engineers concerned with the development of mineral resources.

The volume is divided into 3 parts. The first part, an introductory chapter, The Geophysical Setting of Mineral Districts, by J. Tuzo Wilson (p. 4-19), is separately abstracted below. The second part contains a series of papers on the theory and techniques of geophysics most widely used in mining and civil engineering. These are planned to help the reader unacquainted with geophysical theory to understand the discussions presented in the case histories which comprise the third section of the volume. The geophysical exploration methods are described in the following papers:

Magnetic

Wahl, George. The Compass and the Magnet, p. 21-22.
Westrick, E. W. The Dip Needle, p. 23-24.
Smellie, D. W., and C. W. Faessler. The Magnetometer, p. 25-26.
Scott, H. S. The Airborne Magnetometer, p. 26-34.

Gravitational

Pemberton, Roger. Gravity Meter Surveys, p. 35-38.

Geochemical

Elementary Mining Geophysics. Geochemistry, p. 39-42.
Hawkes, H. E., and Harold Bloom. Heavy Metals in Stream Sediment as an Exploration Guide, p. 42-44.

Radioactive

Brownell, G. M. Nuclear Radiation in Prospecting, p. 45-51.

Electrical

Kelly, Sherwin F. Spontaneous Polarization, or Self-Potential Method, p. 53-59.
Seigel, H. O. The Resistivity Method, p. 59-62.
Ward, S. H., and T. R. Gledhill. Electromagnetic Surveying - Ground Methods, p. 63-70.
Ward, S. H. Airborne Electromagnetic Surveying, p. 71-78.

Seismic

Brown, P. D., and J. Robertshaw. The Seismic Refraction Method, p. 79-80.

The third and major part of the volume contains a series of 32 case histories in mining geophysics (p. 83-357). Five papers deal with Australia, 20 with Canada, 1 with Great Britain, 2 with India, and 1 each with Jamaica, South Africa, Tanganyika, and Uganda. Each of these papers is separately abstracted below in the order in which it appears in the volume. --A. C. Sangree.

1-2285. Wilson, J. Tuzo. THE GEOPHYSICAL SETTING OF MINERAL DISTRICTS (In: Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. Methods and Case Histories in Mining Geophysics: p. 4-19, 10 maps, Montreal, Mercury Press Company, [1959?]) 24 refs.

Some geophysical methods are being used to search large areas for ore, and this raises the question of which are the most favorable areas to choose. It is obvious that areas around existing mining camps and areas which appear favorable but which are covered by thin overburden or water are suitable places to look, but can more precise guides be found? Are there not already some rules? Could more order be found if the geophysical methods were applied to do research upon the nature of the crust as well as to prospect directly?

Some order is already known, and examples are discussed of the relation of some Cu camps to particular mountain structures and of the relation of Au camps to the oldest Precambrian rocks of Keewatin type.

In most prospecting 4 ingredients are now employed, geological data, geophysical data, geological insight, and geophysical calculations. It is suggested that future progress in studying the earth will also employ all 4. What the mining industry needs is neither geologists nor geophysicists but exploration engineers and earth scientists, both trained to use the best of both geology and geophysics in applied studies and in research studies of the earth. --Auth.

1-2286. Smellie, D. W. PEKO COPPER ORE-BODY, TENNANT CREEK, NORTHERN TERRITORY, AUSTRALIA (In: Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. Methods and Case Histories in Mining Geophysics: p. 83-88, 2 maps, plan, cross sec., Montreal, Mercury Press Company, [1959?]) 4 refs.

A magnetic survey in the vicinity of the Peko shaft near Tennant Creek, Northern Territory, Australia, revealed a strong localized anomaly immediately over the outcropping quartz-hematite lode and a 5,500 gamma anomaly from a source which appeared to top at about 300-ft. subsurface. Drilling and subsequent mine development disclosed that the anomaly was due to the unoxidized portion of a pipelike ore zone where chalcopyrite and other sulfides had partially replaced a banded quartz-magnetite rock. --Auth.

1-2287. Horvath, J. GEOPHYSICAL INVESTIGATION OF A COPPER-NICKEL FIELD NEAR ZEEHAN, TASMANIA, AUSTRALIA (In: Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. Methods and Case Histories in Mining Geophysics: p. 89-94, 5 figs. incl. 2 maps (1 in pocket scale approx. 1 in. to 100 ft.), profiles, Montreal, Mercury Press Company, [1959?]) 2 refs.

The Copper-Nickel, or Cuni field, lies on the W. coast of the Island of Tasmania, about 5 mi. NE. of Zeehan. The deposits are in a marshy basin where the bedrock consists of Lower to Middle Cambrian shales, argillites, and tuffs with steep easterly dips, intruded by dikes, and sills of pyroxenite and gabbro 20 to 60 ft. thick and generally paralleling the bedding. The Cu-Ni ore bodies are on the footwall side of the ultrabasic dikes, and are small but extremely rich. They consist of massive sulfides up to 4 ft. thick, and containing as much as 17% Ni, with sulfides,

disseminated as much as 20 ft. into the hanging-wall dikes.

Electrical methods had been tested over part of this area in 1929, with encouraging results. In 1952-1953 the Bureau of Mineral Resources conducted self-potential and electromagnetic surveys over a larger area. A test with magnetic instruments yielded no anomalies, so the magnetic method was not used.

The self-potential profiles revealed only a small anomaly around the Cuni South shaft, but a persistent one around the Cuni North workings. An electromagnetic survey was then done in the N. portion of the area. The indications obtained agreed with those yielded by the self-potential work, but with the anomaly displaced slightly to the E. by the eastward dip of the ore formations.

Drilling disclosed thicknesses of 3 to 4 ft. of high-grade ore and greater thicknesses of disseminated Cu-Ni sulfides. Preparations are being made to re-open the field. --Auth.

1-2288. Debnam, A. H. GEOCHEMICAL PROSPECTING AT MOUNT ISA, QUEENSLAND (In: Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. Methods and Case Histories in Mining Geophysics: p. 94-108, 4 maps, 2 secs., graph, table, Montreal, Mercury Press Company, [1959?]) 13 refs.

Geochemical anomalies in soils over zones of Pb mineralization were studied, both in known mineralized areas and in areas of suspected mineralization. The anomalies were readily detected and outlined by using a dithizone technique on acid extracts of soil samples collected from grid systems.

By assuming the principles of mechanical mixing of the mineralized rock with other material during soil formation, and of downhill migration of soils, the anomalies were correlated with the zones of their origin; the asymmetric anomalies discovered are typical of such conditions.

Applied to areas of suspected mineralization, the geochemical prospecting was responsible for the discovery of 2 new bands of Pb mineralization and several large Pb and Cu anomalies. The method proved extremely useful for indicating the most favorable areas for more detailed prospecting such as diamond or churn drilling and geophysical methods. --Auth.

1-2289. Horvath, J. MAGNETIC SURVEY OF RYE PARK SCHEELITE DEPOSIT, NEW SOUTH WALES, AUSTRALIA (In: Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. Methods and Case Histories in Mining Geophysics: p. 109-111, map, sec., Montreal, Mercury Press Company, [1959?]).

The Rye Park scheelite deposit lies 1 1/2 mi. N. of the village of that name, and 12 mi. SE. of the town of Boorowa, in New South Wales. The bedrock consists of gently dipping Silurian porphyries and dacitic tuffs, intruded by 2 small granite cupolas. Although the soil cover is shallow there are few outcrops, which hindered geological mapping and prospecting. It was found that magnetite accompanied scheelite ore, which has selectively replaced certain beds in the volcanic suite, probably originally calcareous tuffs. A magnetic survey was used to delimit the areas of magnetite-scheelite occurrence.

Magnetic anomalies were found in the marginal area around the N. granite cupola. These anomalies were strong but limited in extent and were interpreted to indicate near-horizontal magnetic bodies at shallow depth and of limited dimensions. Drilling revealed one main, nearly horizontal body, 10 to 20 ft. thick, overlain by a smaller one. Values in W were found to vary more or less with the magnetic intensities. --Auth.

1-2290. Neumann, F. J. G. GEOPHYSICAL EXPLORATION FOR COAL IN GIPPSLAND, VICTORIA (In: Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. Methods and Case Histories in Mining Geophysics: p. 111-115, map, 2 profiles, Montreal, Mercury Press Company, [1959?]) 2 refs.

Hard, brown coal occurs in Tertiary strata, at shallow depth, in Gippsland, Victoria, Australia. Seams have been worked since 1889, and reserves have been diminishing rapidly in recent years. Early exploration drilling failed to discover appreciable reserves, largely because bores must be accurately placed to intersect the seam where it lies on the flank of a steeply dipping monocline.

Gravity studies were used to trace the eastward and northeastward extension at this monocline. Drilling carried out in accordance with recommendations made on the basis of the gravity survey results, subsequently revealed new coal reserves in excess of 100 million tons, and showed that the coal seam continues for a distance of at least 9 mi. --Auth.

1-2291. Morley, L. W. MINING GEOPHYSICS AND ITS FUTURE IN CANADA (In: Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. Methods and Case Histories in Mining Geophysics: p. 117-122, map, Montreal, Mercury Press Company, [1959?])

Informed prospectors and mining companies prefer to be guided in drilling by geological, geochemical, or geophysical indications. In areas of widespread cover, geophysical methods are most promising. Relatively unexplored central areas of the Canadian Shield have greater overburden than the better known outer fringes. Prospecting there, and the drilling of deeper holes in all parts of Canada, will require greater reliance on geophysics. Expenditures for mining geophysics in Canada in 1956 were more than 30% of the world total; most major mining companies spend about 25% of their exploration budget on geophysics.

Present acceptance of geophysical prospecting is largely the result of successes since World War II, caused in part by introduction of airborne devices followed up by ground geophysical work and drilling. Although cost outlays have risen, improved methods result in lower final charges. Geophysical work is only one part of over-all exploration and should complement geological work.

As the volume of work and diversity of methods expand there will be growing need for consultants and contractors. The Government of Canada should contribute to mining geophysics by continuing regional aeromagnetic and gravity surveys and by research and development. The future depends on the caliber of men and their training. Seven Canadian universities now give the Ph. D. in geophysics; support from industry is needed.

Research in instrumentation and technique and in interpretation of geophysical data has been carried on mainly by private companies. Fundamental research has been done by universities and to some extent by government, but not by the mining com-

panies who are urged in the future to support such research. --A. C. Sangree.

1-2292. Low, John H. MAGNETIC PROSPECTING METHODS IN ASBESTOS EXPLORATION (In: Canadian Institute of Mining and Metallurgy, Committee on Geophysicists. Methods and Case Histories in Mining Geophysics: p. 122-134, 8 maps (2 fold., 1 in pocket scale approx. 1 in to 550 ft.), graph, Montreal, Mercury Press Company, [1959?]) 5 refs.

This paper describes the outcome of magnetic surveys made in 1949 in 2 important asbestos-producing areas in eastern Canada, the Thetford Mines-Black Lake area of Quebec and the Munro-Beatty townships area, Ontario.

The results demonstrate that in the Thetford Mines-Black Lake area, especially in the Pennington dike, asbestos deposits are characterized by magnetic field intensities greater than those over surrounding, barren serpentinized peridotite. The method is not fully diagnostic, and other noneconomic, geological features which also give rise to magnetic anomalies have been described. However, combined with available geological data, the magnetic results proved of great help in exploring this area.

In the Munro-Beatty area, magnetic results per se were found less directly applicable, but an indirect approach by which the fault pattern was determined from the magnetic data and the probable locations of new deposits were deduced from the fault pattern, yielded useful information. --Auth.

1-2293. Conn, H. K. MAGNETIC PROSPECTING FOR ASBESTOS DEPOSITS (In: Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. Methods and Case Histories in Mining Geophysics: p. 135-140, 2 maps, profile, Montreal, Mercury Press Company, [1959?]) 2 refs.

A ground magnetic survey was carried out on an asbestos prospect in Garrison Township, Ontario. The data from part of the survey are shown, and the basis of the interpretation is presented for comparison with the actual interpretation. A drilling program planned from the interpretation of the ground magnetic data discovered and localized an important chrysotile asbestos deposit buried under more than 20 ft. of overburden. --Auth.

1-2294. Lundberg, Hans T. THE DISCOVERY OF LARGE LEAD-ZINC DEPOSITS AT BUCHANS, NFLD. (In: Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. Methods and Case Histories in Mining Geophysics: p. 141-154, 17 figs. incl. 3 illus., 5 maps (1 fold., 1 topo. map in pocket), secs., profiles, graphs, Montreal, Mercury Press Company, [1959?]) 18 refs.

Oldest rocks of the Buchans area are Ordovician basic lavas, agglomerates, tuffs, and arkose, intruded by granite diabase and quartz porphyry of pre-Carboniferous age. Sulfide and barite mineralization occurred after intrusion of the quartz porphyry. Tuff is the principal host rock for the barite-sulfide mineralization. The rocks are gently folded.

In June 1926, an equipotential survey was started over 1 sq. mi. around Buchans River mine in central Newfoundland. Method is described. An exploratory diamond drill hole encountered massive Pb-Zn mineralization E. of Buchans River, and this first location was named Oriental. Survey of another small area W. of the river (location Black Fly) also disclosed promising Pb-Zn mineralization. The main ore body at Lucky Strike mine developed W. of the Black Fly location totals 5,300,000 tons of ore of which 85% is high grade. Fifteen percent of the ore is found in lower grade bodies. Mill and railway were finished and the first ore shipped in 1928. Shipments to 1956 totalled 10,000,000 tons. Maps compare the 1926 interpretation of the ore body with the shape and size of the ore developed over the 30-year period. Discovery of Oriental No. 2 ore body was announced in 1956. Studies and methods 1927-1934 are briefly described. --A. C. Sangree.

1-2295. Wahl, W. George, and S. Lake. AIRBORNE MAGNETOMETER SURVEY DISCOVERS MARMORA MAGNETITE DEPOSIT (In: Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. Methods and Case Histories in Mining Geophysics: p. 155-162, 18 figs. incl. illus., 2 maps, Montreal, Mercury Press Company, [1959?])

This property [midway between Ottawa and Toronto, Ontario] was surveyed by compass, dip needle, magnetometer, gravity meter, and by the airborne magnetometer. After mining had started, magnetometer and dip needle surveys were done on the floor of the pit which at that time was approximately 100 ft. subsurface.

The data from the compass survey when contoured show that certain deductions can be made which will define the causative body. This is true also of the dip needle survey results when mapped on the surface. In neither case was the source directly underneath the peak of the anomaly but was offset some 900 ft.

The magnetometer and the gravity surveys defined the ore body as to location, attitude, length, width, and depth of burial.

The data from 9 airborne magnetometer surveys flown at elevations of 100 ft. to 5,000 ft. are presented. It was found that the intensity varied inversely as the square of the distance. A method is presented whereby anomalies from causative bodies of the same or different depths of burial may be ranked according to their relative worth. The following formula is used to determine the intensity per unit area of a magnetic anomaly:

$$\frac{(\text{depth})^2 \times \text{anomaly intensity}}{\text{area}}$$

--Auth.

1-2296. Moyd, Louis. THE NEGATIVE MAGNETIC ANOMALIES OF RIVIERE PORTNEUF AND LAC PAULINE, CHICOUTIMI COUNTY, QUEBEC (In: Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. Methods and Case Histories in Mining Geophysics: p. 163-168, 6 maps (3 in pocket), sec. (in pocket), Montreal, Mercury Press Company, [1959?]) ref.

Airborne magnetometer, ground magnetometer, and dip needle surveys were used in conjunction with geological mapping in exploration for Ti in anorthositic areas in eastern Quebec. Several negative anomalies, - diagnostic of Ti mineralization - were mapped and drilled. The surveys showed that localized disseminations of hematite-ilmenite caused the negative anomalies and titaniferous magnetite the positive anomalies.

Petrographic studies and measurements of the magnetic properties of core specimens were made to explain the negative anomalies and their association

with ilmenite mineralization.

Two of these causes are discussed. --Auth.

1-2297. Bergey, W. R., A. R. Clark, J. C. Frantz, N. B. Keevil, and F. Gordon Smith. DISCOVERY OF COPPER-NICKEL OREBODIES AT THE TEMAGAMI MINE, ONTARIO (In: Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. Methods and Case Histories in Mining Geophysics: p. 168-175, 11 figs. incl. 5 maps, profiles, graphs, Montreal, Mercury Press Company, [1959?])

Geological study, aeromagnetic surveys, and detailed ground geophysical surveys by magnetic, electromagnetic, resistivity, and self-potential methods were used in the Lake Temagami area in the discovery of the large Cu-Ni ore bodies at the Temagami mine.

Selection of the particular area for prospecting was based on the hypothesis that the relatively narrow belt N. and W. of the Huron-Mistassini line was much more favorable for base-metal occurrence than the region as a whole.

Aeromagnetic surveys outlined major formational features. Self-potential surveys were useful on land portions, indicating the intensity of sulfide mineralization and pinpointing the sub-outcrop. The resistivity survey indicated deposits as a whole, and the combined use of self-potential and resistivity gave information regarding dip and plunge of deposits. The electromagnetic surveys outlined the margins of the massive portions of the deposits and were used mainly to check self-potential and resistivity anomalies. --Auth.

1-2298. Koulomzine, T., and Leo Brossard. MAGNETOMETER SURVEYS IN THE AREA OF THE BOURLAMAQUE BATHOLITH AND ITS SATELLITES (In: Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. Methods and Case Histories in Mining Geophysics: p. 176-184, 9 maps (2 fold., 2 in pocket scale 1 in. to 2,000 ft.), 2 profiles, Montreal, Mercury Press Company [1959?]) 11 refs.

Ground magnetometer surveys have played an outstanding role in the development of the Val d'Or mining camp [330 mi. NW. of Montreal, Quebec]. The data observed on many of the individual surveys were used in preparing a large map of the Bourlamaque batholith and its satellites. The information so gained, combined with knowledge of the surface geology and the geological information provided by diamond drilling, permitted the contacts of the batholith to be outlined.

Several rules are presented for guiding the interpretation of ground magnetic data in this area.

The Geological Survey of Canada covered the Val d'Or district with their aeromagnetometer. Some of the data observed are presented and compared with the ground magnetic data. The complementary roles of the 2 methods are clearly established. --Auth.

1-2299. Westrick, E. W., and G. E. Parsons. INTEGRATED EXPLORATION FINDS COLUMBIUM DEPOSITS IN CHEWETT AND COLLINS TOWNSHIPS, ONTARIO (In: Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. Methods and Case Histories in Mining Geophysics: p. 184-195, 6 maps, 2 secs., Montreal, Mercury Press Company [1959?]) ref.

Study of available data indicated a predominantly circular habit for alkalic plugs and diatremes with associated Nb mineralization. A magnetic aureole corresponding to a zone of metasomatic alteration surrounding these alkalic intrusions suggested that magnetic methods might be used to locate similar occurrences. Such phenomena had been observed in the vicinity of Lackner Lake, Ontario. On the basis of these facts, an area of gneisses near the town of Chapleau, Ontario, about 170 mi. NW. of Sudbury, was selected for investigation.

An area of 8 townships was surveyed with an airborne magnetometer at 1,000-ft. altitude on flight-lines half a mile apart. Resultant data indicated an aureole of alteration surrounding an alkalic plug in the vicinity of Lake Nemegosenda in Chewett Township. Detail ground magnetometer work was carried out on the area, together with geological mapping and scintillometer observations. The detail magnetometer observations defined the magnetite-bearing zones and areas of light overburden. The scintillometer readings assisted in outlining areas carrying Nb by reason of the slight radioactivity associated with pyrochlore, the Nb-bearing mineral of this area. Drilling was undertaken on zones indicated by the magnetic and radioactive observations, and scintillometer readings were used in evaluating the cores for sampling and assaying. A pyroxenitic zone, in the form of a "basic front" around the syenitic contact zone, was found to be the principal carrier of the Nb mineralization.

Two principal ore areas have been discovered to date, one of which probably will be a major open-pit operation. A large area which appears to be favorable for Nb mineralization, from geological considerations and magnetic evidence, awaits further testing. --Auth.

1-2300. Ratcliffe, John H. THE BOSTON TOWNSHIP IRON RANGE (In: Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. Methods and Case Histories in Mining Geophysics: p. 195-210, 9 figs. incl. 6 maps, profiles, graphs, Montreal, Mercury Press Company [1959?]) 9 refs.

The Boston Township Fe range [6 mi. SE. of the town of Kirkland Lake, District of Timiskaming, Ontario] has been prospected for Au, nonferrous metals, and Fe since 1902 or 1903. In 1951, concentrated exploration based on aeromagnetic surveys, geological mapping, and ground magnetometer surveys led to the development of 213,000,000 tons of Fe ore averaging approximately 20.6% magnetite which can be magnetically concentrated to produce a high-grade product suitable for blast furnace use. However, not all of this material is economic under present conditions.

Some interesting features of the geomagnetic surveys which came to light during the exploration, were the steep magnetic gradients encountered in the area, the extreme magnetic intensities, both positive and negative, measured by the ground magnetometer, and the possibility of outlining potential magnetite ore zones on the basis of ground magnetometer data and detailed geological mapping.

While the exploration was designed primarily to outline Fe ore bodies, several problems of academic interest were met. Detailed ground magnetometer profiles measuring anomalies in the vertical component of the earth's magnetic field of 250,000 gamma and 65,000 gamma are shown in conjunction with the accompanying angles of inclination, magnetic deviations, and geology.

By comparing the detailed geology with the ground

magnetometer data, it was possible to select a cut-off value of 40,000 gamma above base level as an aid in outlining possible magnetite ore zones. Recent diamond drilling has shown that this succeeded in locating all the ore zones, thus justifying the use of this rule-of-thumb method on this property. --Auth.

1-2301. Fleming, H. W. MAGNETIC AND ELECTROMAGNETIC INVESTIGATIONS IN PASKA TOWNSHIP, DISTRICT OF THUNDER BAY, ONTARIO (In: Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. Methods and Case Histories in Mining Geophysics: p. 210-220, 8 figs. incl. 2 maps, profiles, graphs, Montreal, Mercury Press Company, [1959?])

The results of an exploration program organized to investigate some large aeromagnetic anomalies which indicated large extensions to the known Onaman Fe range, are discussed and compared with the predictions made from the interpretation of the magnetic data.

It was found that a high apparent susceptibility of about 0.50 c. g. s. units for magnetite was required to satisfy the anomalies when compared to the true magnetite content of the Fe formation. This susceptibility factor, in conjunction with variations in overburden cover and magnetite content in the Fe formation, appeared adequate to satisfy even the larger variations in the anomalies where overburden cover was heavy, but was inadequate where overburden cover was light and the extreme variations were encountered.

It is, therefore, concluded that normal and inverse remanent magnetization must play an important role, and that the apparent high uniform susceptibility in regions under heavy overburden is due to the integrated effect from relatively narrow zones having widely different values for remanent magnetization.

After regional geologic investigations and photographic interpretation, a reconnaissance ground electromagnetic survey and a magnetic survey were carried out in regions adjacent to the Fe formation, and subsequently test flights were made with aero-electromagnetic equipment to obtain a general comparison with the ground data. These surveys and the interpretations from the data are discussed in relation to the drilling results obtained.

Such combined survey methods are shown to possess a good degree of accuracy and can give technically satisfactory results if properly interpreted and reassessed as exploration progresses. --Auth.

1-2302. Ward, Stanley H. THE ROLE OF GEOPHYSICS IN EXPLORATION IN NEW BRUNSWICK (In: Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. Methods and Case Histories in Mining Geophysics: p. 221-226, 5 figs. incl. 2 maps, graphs, Montreal, Mercury Press Company, [1959?])

Over the period 1952-1957, geologists, geophysicists and geochemists have gradually accumulated basic information concerning the impact of climate, topography, overburden, bush conditions, travel difficulties, ease of acquisition of property, and specific geological and geochemical conditions, on exploration in central New Brunswick. Consequently there has been a gradual but persistent transition in the exploration procedures used during the period in question. Throughout this transition, more and more emphasis has been placed on the adaptation of geochemical and geophysical techniques to the search for sulfide mineralization. The typical result is a scientific exploration program differing radically from the previous custom of adding geophysical and geochemical techniques as appendages to an exploration program built around geological knowledge. Ore has been found by the new types of exploration programs.

In this paper, some of the exploration sequences used during the last five years in New Brunswick are discussed and illustrated with examples of both successes and failures. There is serious doubt concerning the economic advisability of uniform application of one fixed exploration sequence. The paper concludes with the observation that any exploration technique and sequence should be subject to constant review and revision for it to meet the economic, geological, and physical demands of the area of application. --Auth.

1-2303. McMurry, H. V. EXPLORATION OF A FORTY-SQUARE-MILE TRACT NEAR CAMERON LAKE, QUEBEC (In: Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. Methods and Case Histories in Mining Geophysics: p. 226-236, 13 figs. incl. 7 maps, profiles, logs, Montreal, Mercury Press Company, [1959?])

Electromagnetic and magnetic surveys were employed to survey a 40-sq. mi. claim block near Cameron Lake, Quebec. Numerous conductors were found in areas underlain by volcanic tuffs and flows. Fe-formation bands in a belt of metamorphosed sediments also were mapped. The conductors tested by drilling were chiefly graphitic schists or carbonaceous sediments. Some sulfide mineralization was found, none of which approached ore grade, and minor amounts of Au were found in association with structurally disturbed portions of certain Fe-formation bands. --Auth.

1-2304. Seigel, Harold O., H. A. Winkler, and J. B. Boniwell. DISCOVERY OF THE MOBRUN COPPER LTD. SULPHIDE DEPOSIT NORANDA MINING DISTRICT, QUEBEC (In: Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. Methods and Case Histories in Mining Geophysics: p. 237-245, 7 figs. incl. map, profiles, graphs, Montreal, Mercury Press Company, [1959?]) 4 refs.

The Mobrun sulfide deposit was discovered by geophysical methods in an area which has been prospected intensively for 40 years. The initial discovery was made by vehicle-borne electromagnetic instruments, and the conductor was determined to be of interest by virtue of a 1.3 mgal. gravity anomaly with which it correlated. After the discovery, detailed electromagnetic, gravimetric, resistivity, magnetometric, spontaneous polarization, and geochemical soil surveys were employed to give additional information. Quantitative interpretation of the results of the electromagnetic, gravimetric, and resistivity surveys enabled accurate estimates of the following features of the sulfide body to be made prior to the drilling: a) depth of cover; b) average percentage of sulfide content in the central sections; c) length, width and attitude; d) total tonnage of sulfides.

The magnetometric, spontaneous polarization, and soil sampling surveys gave no useful results as the body is nonmagnetic and buried under the permanent water table beneath a shallow mantle of lacustrine

clay. The nearest outcrop, nonmineralized rhyolite, is 1,600 ft. distant from the sulfide body. --Auth

1-2305. Paterson, N. R. A SULPHIDE DISCOVERY, ROBB-JAMIESON AREA, ONTARIO (In: Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. Methods and Case Histories in Mining Geophysics: p. 246-259, 9 figs. incl. 7 maps (1 in pocket scale 1 3/4 in. to 1 mi.), 2 tables, Montreal, Mercury Press Company, [1959?]) 9 refs.

The Robb-Jamieson area, just W. of Timmins in northern Ontario, was prospected for Au in the early years of this century. More recently, attention has been directed at the search for base-metal sulfide deposits, particularly of Cu and Zn.

The bedrock consists of Precambrian lavas and volcanic fragmentals, tightly folded and intruded by both acidic and basic igneous rocks. The sulfide bodies are hydrothermal replacement deposits in the lavas, controlled by shearing and brecciation, and probably are related to intrusive rocks. A deep mantle of glacial clay and sand covers much of the bedrock, and for this reason geophysical techniques were used extensively and were relied upon in the search for new deposits.

A large area was surveyed first by a detail aeromagnetometer survey, next by reconnaissance geological mapping, and then by extensive ground geophysical investigation. These surveys were used to guide the staking, optioning, and purchasing of claims, and the lines cut for the geophysical work were employed in detail geological mapping.

Most of the claims acquired have been subjected to examination by one or more of the geochemical, self-potential, resistivity, gravity, magnetic, and electromagnetic techniques. The magnetic method was valuable in resolving geological problems; electrical methods showed the positions and dimensions of sulfide bodies; gravity measurements helped in the differentiation of electrical conductors. Subsequent drilling verified the presence of a sulfide deposit estimated to contain at least 7,000,000 tons running 25% combined pyrite, chalcopyrite, and sphalerite. --Auth.

1-2306. Hawkes, H. E., Harold Bloom, and J. E. Riddell. STREAM SEDIMENT ANALYSIS DISCOVERS TWO MINERAL DEPOSITS (In: Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. Methods and Case Histories in Mining Geophysics: p. 259-268, 6 figs. incl. 4 maps, 5 tables, Montreal, Mercury Press Company, [1959?]) 4 refs.

Reconnaissance geochemical surveys based on sediment analysis were carried out in the streams in an area of over 27,000 sq. mi. in the province of New Brunswick and the Gaspé peninsula, Quebec. These surveys located 9 areas of above normal soluble heavy metal content, and these areas were then covered by extensive integrated exploration programs.

The exploration techniques applied in 2 of the areas are discussed, and conclusions are drawn on the effectiveness of geochemistry in mineral exploration. --Auth.

1-2307. Chisholm, Edward O. GEOPHYSICAL EXPLORATION OF A LEAD-ZINC DEPOSIT IN YUKON TERRITORY (In: Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. Methods and Case Histories in Mining Geophysics: p. 269-277, 5 maps (3 in pocket scale approx. 1 in. to 200 ft.), sec., 2 profiles, Montreal, Mercury Press Company, [1959?])

Self-potential and magnetometer surveys were followed by a gravimetric survey in the northwestern cordillera to outline successfully a flat-lying Pb-Zn sulfide replacement deposit beneath 50 ft. of glacial overburden. This site of the survey is [at the headwaters of Vangorda Creek], 125 mi. NE. of Whitehorse, in mountainous terrain. Detailed diamond drilling verified the accuracy of the survey both as to boundaries and estimated tonnage of the deposit. Auxiliary surveys were carried out by aeromagnetic and geochemical methods. Graphitic schists interfered with the self-potential readings, but geochemical and magnetic results were helpful for indicating favorable terrain. --Auth.

1-2308. Warren, Harry V., Robert E. Delavault, and Christine H. Cross. GEOCHEMICAL ANOMALIES RELATED TO SOME BRITISH COLUMBIA COPPER MINERALIZATION (In: Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. Methods and Case Histories in Mining Geophysics: p. 277-282, illus., map, 9 graphs, Montreal, Mercury Press Company, [1959?]) 8 refs.

Geochemical techniques were applied to prospecting for Cu in 3 areas in the S. part of British Columbia. Soil and vegetation samples were collected along profiles over strong, medium, and weak Cu mineralization. The analyses were plotted on profiles, and the mineralization, as determined by various methods, is shown. Large geochemical anomalies were obtained over the areas of significant Cu mineralization. The ratios of the p. p. m. of Cu to the p. p. m. of Zn present in the samples were computed and plotted as aids in interpretation. The techniques were found to be effective for exploration in the section of British Columbia under study. --Auth.

1-2309. Kelly, Sherwin F. RESISTIVITY AND MAGNETIC SURVEYS IN 1936 ON THE BROULAN-PORCUPINE GOLD PROSPECT, SOUTH PORCUPINE, ONTARIO (In: Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. Methods and Case Histories in Mining Geophysics: p. 283-289, 2 maps (1 fold.), 3 graphs, Montreal, Mercury Press Company, [1959?]) 8 refs.

In 1936, the Broulan-Porcupine Mines, Ltd., held some claims in the newly developed eastern extension of the Timmins Au-producing area in eastern Ontario. Paucity of outcrops made effective orientation of drilling difficult, so it was decided to utilize electrical resistivity and magnetic surveys to assist in outlining potentially Au-bearing zones. The magnetic results assisted in locating a lava-sediment contact near which most of the known mineralization in that district occurred. The electrical resistivity survey defined areas of high electrical resistivity which were presumably silicified zones. The Au mineralization in the region was known to be associated with quartz veins and zones of silicification. Therefore, high resistivity indications provided a logical objective for the drilling campaign, which resulted in subsequent discovery of the Broulan-Porcupine ore bodies. Maps accompanying the article show the relationship of the ore bodies to zones of high resitivity. --Auth.

1-2310. Kelly, Sherwin F. SPONTANEOUS POLARIZATION SURVEY ON NORANDA MINES, QUEBEC, 1924 (In: Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. Methods and Case Histories in Mining Geophysics: p. 290-292, 3 fold. maps, fold. profiles, Montreal, Mercury Press Company, [1959?]) 4 refs.

The first systematic survey by the spontaneous polarization method in the Western Hemisphere was carried out in 1924 on the Horne Mine of Noranda Mines Ltd., in western Quebec. Drilling of this prospect was commenced, but as the pattern of mineralization was obscure it was decided to try the then new electrical technique to see if it would assist in orienting the drilling program. Numerous centers of electrical activity were mapped, and their relationship to the subsequently discovered sulfide bodies is shown on the illustrations accompanying the article. The advantage is demonstrated of basing the interpretation on equipotential contours, rather than on the original technique of relying solely on peaks on the profiles. Maps originally presented with the report are reproduced for comparison with the modern type of representation. --Auth.

1-2311. Brown, P. D., and J. Robertshaw. DETERMINING THE THICKNESS OF UNCONSOLIDATED DEPOSITS OVERLYING SHALLOW MINE WORKINGS BY SEISMIC REFRACTION (In: Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. Methods and Case Histories in Mining Geophysics: p. 295-300, 2 maps, 4 graphs, Montreal, Mercury Press Company, [1959?])

Seismic refraction was used to determine the thickness of the weathered and unconsolidated glacial layers overlying the coal measures in 2 National Coal Board coalfields [NW. of Liverpool, England]. Depths to the bases of these layers varied from 5 ft. to 25 ft., and from about 40 ft. to 150 ft. respectively. Standard 12-trace equipment was used. Profiles were read along 5 traverses laid out to cover existing boreholes. Roughly 6,000 ft. of profiling was done at a normal speed of 1 mi. per week. Weathered layer velocity data were augmented by direct measurements made in auger holes. Depths were calculated by the time-intercept method.

Velocities measured at the 2 sites varied from 1,600 ft./sec. to 3,000 ft./sec. for the weathered layer, 4,200 ft./sec. to 5,500 ft./sec. for the glacial deposits, and 7,400 ft./sec. to 11,500 ft./sec. for the consolidated rock. A 50% velocity anisotropy was shown in one sandstone bed by measurements made in 2 directions. A low-speed layer within the glacial deposits was interpreted from discontinuities in the time-distance curves. It was necessary to estimate both velocity and thickness of this layer in order to find the depth to the underlying rock.

Calculated depths to bedrock on the 2 sites agreed within 6% with depths indicated by the boreholes. --Auth.

1-2312. Rao, M. B. Ramachandra, and S. C. Sinha. MAGNETIC SURVEYS FOR THE EXPLORATION OF MANGANESE ORES IN INDIA (In: Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. Methods and Case Histories in Mining Geophysics: p. 301-311, 6 figs. incl. 4 maps, profiles, 2 tables, Montreal, Mercury Press Company, [1959?]) 3 refs.

Abundant resources of Mn occur in India, the most important field lying in Madhya Pradesh State (formerly the Central Provinces). This field is 150 mi. long, and the ores occur in large bands or reefs, but with outcrops often discontinuous and covered by alluvium. It was to fill in some of these gaps that geophysical work was carried out by the Geological Survey of India.

The Mn ores of this area are associated with the Gondite series of Archean age, consisting of mica schists, gneisses, calc-granulites, and limestones. The rocks are mostly banded, with lenticular and ribbon structures. The ores generally follow the same trends as the rocks and consist principally of braunite and psilomelane, with other Mn minerals. The deposits are believed due to the metamorphism of Mn-bearing sediments.

Although first attempts at using electrical resistivity and spontaneous polarization were disappointing, more recent studies have been reported successful. In the exploration reported here, however, solely magnetic anomalies were relied upon. The magnetic reactions varied from plus 100 to plus 25,000 gammas, and were of 2 kinds. One showed circular to irregular patterns of magnetic contours with irregular distribution; the other consisted of fairly strong indications with elongated contours and definite strike trends.

The strong elongated contours usually are due to bands of magnetite-quartzite or magnetite-bearing schists, of no economic significance. The few places where it is thought they might be due to Mn mineralization have been designated for later exploration.

Investigation of the irregular anomalies of isolated character has located probably 50,000 tons of ore, mostly "float."

Several typical areas are selected for discussion of the magnetic anomalies, and the results obtained by test-pitting are reported. The magnetic anomalies are believed due to the presence of jacobsite, a magnesium-iron manganate, although this being a supergene mineral, it presents difficulty in accounting for anomalous remanent magnetism. It is suggested that gravitational surveys could be used advantageously to supplement the magnetic work. --Auth.

1-2313. Rao, M. B. Ramachandra, and M. M. Suryanarayana Rao. ELECTRICAL SURVEYS FOR EXPLORATION FOR SULPHIDE ORES IN INDIA (In: Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. Methods and Case Histories in Mining Geophysics: p. 312-322, 3 maps, 4 secs., 4 profiles, Montreal, Mercury Press Company, [1959?]) 9 refs.

Scattered indications of Cu and numerous old workings in several mineralized belts in India attest the occurrence of ores which may not have been worked out by the ancient miners. In 1939 the Government of Mysore initiated geophysical investigations on some of these deposits, and in the last decade the Government of India has been carrying out systematic geophysical exploration for sulfide ores. Some 100 sq. mi. have thus been covered in the states of Madras, Mysore, and Rajasthan. Numerous promising indications remain to be tested, but the results obtained in the Chitaldrug belt at Ingaldhal and G. R. Halli areas, Mysore State, are given in this paper.

At Guddadarangavvanahalli (G. R. Halli) spontaneous polarization surveys revealed numerous negative and positive centers with the same trend as outcrops of chalybitic trap rocks. Sinking and crosscutting showed the underlying mineralization to be a lode of pyritiferous graphitic schist. Its economic importance is unproved

but is considered promising.

At Ingaldhal both spontaneous polarization and resistivity were used, plus magnetic observations, and revealed a belt of anomalies about 2,000 ft. long. Test-pitting and trenching disclosed a massive pyrite body estimated to contain over one million tons of pyrite suitable as a S ore. This is the first massive S body to be discovered in that area. --Auth.

1-2314. Vincenz, S. A., and H. R. Versey. THE APPLICATION OF THE RESISTIVITY METHOD TO HYDROGEOLOGICAL PROBLEMS IN JAMAICA (In: Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. Methods and Case Histories in Mining Geophysics: p. 323-340, 6 maps, sec., 14 graphs, 2 tables, Montreal, Mercury Press Company, [1959?]) 10 refs.

Two examples of the use of resistivity measurements in locating water for irrigation purposes are described.

The first example deals with a resistivity survey of a waterlogged area, to trace gravel lenses and to locate the site for a borehole expected to give a higher yield of water than is obtained from the existing well. Resistivity curves obtained with Cooper's electrode arrangement suggested 2 electrode separations for the Wenner arrangement used in constant electrode separation surveys of the area. The results of the 30- and 60-ft. separation surveys are shown in the form of equiresistivity maps, and the interpretation of these is facilitated by a corresponding map of isoratios of the resistivities obtained with the 2 electrode separations. This procedure is shown to remove much of the disturbing influence of variable surface resistivity. In consequence, a site is suggested for another well, but it is pointed out that an output much larger than from the existing well can hardly be expected, and this conclusion is confirmed by a second borehole.

The second case is one of the determination of the thickness of an unconsolidated overburden resting on a limestone aquifer. Wenner and Copper depth probes were done near the existing well and at the site where the information was required. The resulting 2 sets of resistivity curves are interpreted by curve matching and empirical (rule of thumb) methods. The conclusions is that the curves obtained with Cooper's arrangement give on the whole more satisfactory results than those obtained with Wenner's, though in both cases depths to rockhead of the same order of magnitude are obtained. --Auth.

1-2315. Weiss, Oscar. GEOPHYSICAL SURVEYS DISCOVER STILFONTEIN GOLD MINE IN SOUTH AFRICA (In: Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. Methods and Case Histories in Mining Geophysics: p. 341-345, 4 maps (1 fold.), 2 secs., table, Montreal, Mercury Press Company, [1959?])

Stilfontein and surrounding areas gave negative results in all prospecting since about 1904 when Goerz and Company, a forerunner of Union Corporation Ltd., first drilled in the region and on the farm Stilfontein. Subsequent efforts by African and European Investment Company and Anglo American Corporation from 1934-1937 were unsuccessful. Holes drilled by these companies on the farms Rietfontein, Hessie, and Palmietfontein were stopped in the lower Witwatersrand system without finding payable reefs.

The results of gravimeter, ground magnetometer, and aerial magnetometer surveys are presented in the area in and around the new Stilfontein Au mine, in the Klerksdorp district, Transvaal, Union of South Africa. The gravimeter and ground magnetic surveys were completed in 1947-1948. The gravity anomalies suggested a block of upper Witwatersrand quartzites faulted up between denser rocks of dolomite and Ventersdorp lava. Boreholes, S. T. 1, 2, and 3 were drilled in 1948 and, after penetrating the dolomite and the Ventersdorp lava, entered upper Witwatersrand quartzites and intersected the Gold Estates reef and the Vaal reef. Subsequent drilling delineated the suboutcrop of the Vaal reef and determined the main structure of this horizon. The gold content of the Vaal reef was highly payable, and shaft sinking was undertaken. Stilfontein Gold Mining Company was formed to develop and operate the mine. The Vaal reef pay zone extends further S. from Stilfontein, the reef descending at increasing depths. It is probable that at least another mine may be established on these deeper levels. --Auth.

1-2316. King, Anthony J. A GEOPHYSICAL INVESTIGATION OF AURIFEROUS REEFS IN SOUTHERN TANGANYIKA (In: Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. Methods and Case Histories in Mining Geophysics: p. 347-352, 2 maps, profiles, graphs, 2 tables, Montreal, Mercury Press Company, [1959?])

Electrical resistivity and magnetic methods were used to locate extensions of the Au-bearing Galena reefs, in the Lupa goldfield of S. Tanganyika. These quartz reefs, or veins occupy shears about 20 ft. wide in Archean granitic gneiss and were expected to yield high resistivity and low magnetic values. These characteristics were employed in an effort to trace the suspected extensions of the reefs to the S. of an intersecting dolerite dike, and the results showed that the reefs lie probably a little E. of their previously suspected position. Extraneous factors, namely, depth of soil cover, thickness of decomposed rock, and position of water table, were found to influence the resistivity readings and had to be taken into consideration when interpreting the results. --Auth.

1-2317. Holman, R. H. C., and John S. Webb. EXPLORATORY GEOCHEMICAL SOIL SURVEY AT RUHIZA FERBERITE MINE, UGANDA (In: Canadian Institute of Mining and Metallurgy, Committee of Geophysicists. Methods and Case Histories of Mining Geophysics: p. 353-357, map, graphs, table, Montreal, Mercury Press Company, [1959?])

W mineralization, from mesothermal to pegmatitic in type, exists in metamorphosed Precambrian sediments of the Kigezi district, Uganda, East Africa. At the Ruhiza mine, the ore body consists of ferberite in a ramifying mass of narrow quartz veins and stringers which follow a steeply dipping shear zone in graphitic and sandy phyllites.

Samples of the residual soils obscuring the bedrock were tested for W with a stannous-chloride-dithiol technique. Regional background concentrations of W in soils overlying nonmineralized sedimentary rocks varied between 4 and 6 p. p. m., increasing to between 6 and 12 p. p. m. near the Ruhiza deposit. Over the ore body, concentrations were erratic and rose to between 20 and 40 p. p. m., occasionally reaching 100 p. p. m. --Auth.

7. GEOCHEMISTRY

See also: Geophysics 1-2288, 1-2306, 1-2308, 1-2317; Mineralogy 1-2350; Igneous and Metamorphic Petrology 1-2355.

1-2318. Bennington, Kenneth O. ENERGY TRANSFER FROM DIFFERENTIATION IN A DIFERENTIAL [SIC] PRESSURE SYSTEM UNDER NON-EQUILIBRIUM CONDITIONS: Jour. Geology, v. 67, no. 2, p. 171-197, 4 graphs, 12 tables, March 1959, 100 refs.

A model is presented which related the differential pressures in a dynamic system to the ensuing differentiation and temperature differences progressing under nonequilibrium conditions. A method is developed for subdividing the heat of formation of silicates among the constituent oxides, in order to trace recrystallization under shearing stress, leaving a residual depleted mass deposited under endothermic conditions in one area and a contemporaneously developed enriched mass formed under exothermic conditions in the adjacent low-pressure area. The mobile material is shown to create the thermal gradient against which it migrates. The "stability" of a crystal is considered in relation to the proportional ΔH values of the constituent oxides, recrystallization being related to the threshold energy values for the weakest bonded oxides. The relative affinities that oxides have in different crystal structures are interpreted as a measure of the "internal stress" in a crystal, and the varying response of the individual oxides to an activation causes recrystallization and accounts for incongruent melting phenomena and a sequence in the release of mobilized constituents. The migrating material is considered to transfer its energy of activation from the point of departure to the point of final deposition. The changes in temperature in both areas are interpreted as the results of this process. --Auth.

1-2319. Klingsberg, Cyrus, and Rustum Roy. STABILITY AND INTERCONVERTIBILITY OF PHASES IN THE SYSTEM Mn-O-OH: Am. Mineralogist, v. 44, no. 7/8, p. 819-838, 3 graphs, 8 tables, July-Aug. 1959, 13 refs.; also pub. as: Pennsylvania State Univ., Dept. of Geophysics & Geochemistry, Contr. no. 58-46.

Equilibrium and nonequilibrium reactions in the system Mn-O-OH have been studied under high water pressures and with varying O pressures. Reproducible syntheses of well-crystallized pyrochroite ($Mn(OH)_2$) and manganite ($MnO(OH)$) are described. The univariant p-t curves for the reactions $Mn(OH)_2$ $MnO + H_2O$ and $2MnOOH = Mn_2O_3 + H_2O$ have been determined. At 15,000 p. s. i. they pass through points at 392° C. and 272° C. respectively and are very steep in the range 3,000 to 25,000 p. s. i. H_2O pressure. The isomorphous minerals, groutite and ramsdellite, have been shown to be interconvertible by low temperature oxidation or reduction. A phase intermediate in composition between these 2 and presumably of the same structure has been synthesized. Hydrohausmannite is shown to be unstable above 100° C. No evidence was obtained for partial entry of protons into either pyrolusite or ramsdellite to give solid solutions towards the MnOOH composition. --Auth.

1-2320. Jeffery, P. G. THE GEOCHEMISTRY OF TUNGSTEN, WITH SPECIAL REFERENCE TO THE ROCKS OF THE UGANDA PROTECTORATE: Geochim. et Cosmochim. Acta, v. 16, no. 4, p. 278-295, 8 graphs, 14 tables, July 1959, 25 refs.

In recent years the quality of the abundance data for many elements has improved considerably. One exception to this is the data for W, which is still very sparse and contradictory in character. In this paper the use of a new photometric procedure for the determination of W is described, and new abundance data presented. The sampling is restricted to a small area, but in spite of this limitation, the survey is considered to be of general interest to geochemists.

The distribution of W in silicate rocks is shown to be positively skewed, and where sufficient numbers of determinations have been made, is shown to approximate to lognormal. A value of 1·4 p. p. m. is recommended for the terrestial abundance of W in granitic rocks; further work is required before the abundance values given for carbonate and other silicate rocks can be considered to be of general application. Regional bias of the distribution of this element in granitic rocks, and variation of W content with age in the sedimentary rock systems have been recorded. These observations are considered in relation to the general geochemistry of W and the distribution of this element in rock-forming minerals. --Auth.

1-2321. Starik, I. E., L. Ya. Atrashenok, and A. Ya. Krylov. DETERMINATION OF URANIUM IN ACCESSORY MINERALS (In: Soviet Research in Analytical Chemistry of Uranium, 1955-1957. In English Translation: p. 49-51, table, New York, Consultants Bureau, 1959) 3 refs.

A method of quantitatively measuring the amount of U present in microcrystals or parts of crystals is described, in which the mineral specimen is directly fused with a bead of sodium fluoride and the luminescence measured. By this method can be measured the amount of U present in specimens of the order of hundredths of a milligram. --M. Russell.

1-2322. Snyder, J. L. DISTRIBUTION OF CERTAIN ELEMENTS IN THE DULUTH COMPLEX: Geochim. et Cosmochim. Acta, v. 16, no. 4, p. 243-277, 3 maps, 44 graphs, 27 tables, July 1959, 40 refs.

Forty-five samples of mafic rock were obtained at approximately 1/2-mi. intervals along 2 traverses across the strike of the Duluth complex [NE. Minnesota]. From these, spectrographic analyses of olivines, pyroxenes, and plagioclases were made. Along the Ham-Brule traverse, the concentration of elements shows strong local fluctuations but no apparent over-all trend. Along the Kawishiwi traverse, the MgO, NiO, and Cr_2O_3 of the olivines show a progressive increase upward, whereas the FeO, MnO, CoO, CuO, and ZrO_2 decrease upward, and the TiO_2, V_2O_3, and Sc_2O_3 exhibit no consistent trend. Associated feldspars show an upward increase in MnO and CaO; an upward decrease in MgO, FeO, CuO, and Na_2O_3; and an erratic variation in NiO and TiO_2.

The trends in the Kawishiwi area are just the reverse of those found in most stratified mafic igneous bodies. They perhaps are the result of multiple injections from a differentiating magma source, with each successive injection emplaced immediately beneath its predecessor. In the Ham-Brule area successive injections were probably cross-cutting, yielding erratic distribution of younger fractions along the traverse line. --Auth.

1-2323. Tanner, Allan B. METEOROLOGICAL INFLUENCE ON RADON CONCENTRATION IN DRILLHOLES: Mining Engineering, v. 11, no. 7, p. 706-708, 4 figs., July 1959, ref.

The concentration of Rn^{222} in drillholes in uraniferous limestone near Grants, New Mexico, was observed to change markedly with different meteorological conditions. Continuous records of wind velocity, surface temperature, and atmospheric pressure were obtained for a 20-day period during which a series of analyses was made for the Rn content of air collected at several depths in a 4 1/4 in. diameter drillhole. More limited investigations were made of several other drillholes. --Auth.

1-2324. Strakhov, N. M., K. F. Rodionova, and E. S. Zalmanzon. A CONTRIBUTION TO THE GEOCHEMISTRY OF RESERVOIR FORMATIONS: THE LOWER FRASNIAN OF THE VOLGA-URALS [in 3 parts]. Translated by Mark Burgunker: Internat. Geology Rev., v. 1, no. 5, p. 1-23, May 1959; no. 6, p. 11-47, June 1959; no. 7, p. 41-61, July 1959, map, chart, 26 graphs, 86 tables, 51 refs.

The hydrocarbon concentrations in rocks of Frasnian, Givetian, and Famennian age are considerably higher than the concentrations in other units in the Devonian section of the Volga-Ural province, U. S. S. R. The maximum hydrocarbon concentration occurs in the Domanik, which is the host for the largest accumulation of ancient organic material on the Russian platform.

The correlation of hydrocarbon A with oils and other hydrocarbons and with organic C is very low. Trace elements are distributed uniformly throughout clastic sediments and differentially in precipitates, including clays, marls, and limestones. Fe, Mn, P, Cu, and Sr concentrations increase as the host rocks become more clastic; Cr, Nb, and Co decrease. This difference is an additional criterion for mapping ancient pelagic zones and shorelines. However, weathering may lead to artificial concentrations for the various elements. --Auth.

1-2325. Swarzenski, Wolfgang V. DETERMINATION OF CHLORIDE IN WATER FROM CORE SAMPLES: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 8, p. 1995-1998, table, Aug. 1959.

Two methods were used to determine the chloride content in water from cores taken in southwestern Nassau County, Long Island, New York, during tests to find the salt-water front. The centrifuge-extraction method successfully yielded water samples from sands, clayey sands, and silts for chloride determinations as low as 200 p. p. m. A dilution method was devised for clays and silty clays, and is based on the assumption that all salts in the formation fluid are precipitated during drying and redissolved when an excess of distilled water is added to the dried sample. During coring operations, the addition of fluorescein dye to the drilling fluid makes it possible to separate by inspection the contaminated portions of the cores before making determinations. --M. Russell.

1-2326. McGill, David A., Nathaniel Corwin, and Bostwick H. Ketchum. THE TEMPERATURE CORRECTION OF OCEANIC INORGANIC PHOSPHORUS ANALYSES: Deep-Sea Research, v. 6, no. 1, p. 60-64, 2 graphs, 3 tables, 1959, 7 refs.; also pub. as: Woods Hole, Mass., Oceanog. Inst., Contr. no. 1047.

The color intensity of the molybdate-blue complex in the analysis for inorganic P in sea water increases 1.25% per degree centigrade. The apparent P content of sea-water samples analysed in tropical regions may be erroneously high unless temperature is controlled or corrections are made. The effect of temperature-correlation on the agreement between total and inorganic P contents of Atlantic Ocean water is described. It is recommended that temperature corrections be included in future publications of data on the distributions of inorganic P. --Auth.

1-2327. Ault, W. U., and J. Laurence Kulp. ISOTOPIC GEOCHEMISTRY OF SULPHUR: Geochim. et Cosmochim. Acta, v. 16, no. 4, p. 201-235, diag., 2 graphs, 12 tables, July 1959, 44 refs.; also pub. as: Columbia Univ., Lamont Geol. Observatory, Contr. no. 330.

The isotopic composition of S has been determined for a large number of specimens representing the important geochemical phases in which S is present. The most significant process that causes S isotopic fractionation is the reduction of dissolved sulfate by bacteria, although other processes such as distillation of volcanic emanations, oxidation-reduction of H_2S, SO_2, and S during volcanism, and sulfide-sulfate equilibrium under magmatic or hydrothermal conditions can be locally important.

The new data are combined with earlier work in an attempt to define the range and average S^{32}/S^{34} ratio of the various S-bearing phases of the crust. The most important averages are meteorites 22·21, ocean sulfate 21·76, mafic rocks 22·16, plutonic silicic rocks 22·13, hydrothermal sulfides 22·13, and sedimentary sulfide 22·49, and post-Cambrian evaporite sulfate 21·80. A material balance calculation of the S isotopes in the crust, although subject to considerable uncertainties, points to an average crustal composition of S heavier than that for meteorites.

No age effect is found for at least the last 2×10^9 years. Finally, a geochemical theory is described to account for the apparent distribution of S isotopes in the lithosphere. --Auth.

1-2328. Vogel, J. C. ÜBER DEN ISOTOPENGEHALT DES KOHLENSTOFFS IN SÜSSWASSERKALKABLAGERUNGEN [ON THE CARBON ISOTOPES IN FRESH-WATER LIMESTONES]: Geochim. et Cosmochim. Acta, v. 16, no. 4, p. 236-242, fig., table, July 1959, 16 refs.; text in German, abs. in English.

An attempt is made to interpret the observed C^{13}/C^{12} ratio in fresh-water carbonates in terms of the origin of the C and the isotope exchange constants involved. Measurements of the isotope ratio of the inorganically dissolved C in hard ground waters are reported. It appears that the average depletion in C^{13} content of about 14°/oo compared with Solenhofen limestone can be explained quite satisfactorily on this basis. It is shown that the expected isotope ratio of calcium carbonate precipitated from such water is compatible with that of sinter. A few measurements of sinter samples are given, and the results on a number of loess samples are discussed. Although considerable caution is necessary when applying isotopic data to

geological problems, it is felt that with a better understanding of the mechanisms valuable conclusions can be drawn from the C^{13}/C^{12} ratio of carbonates. --Auth.

1-2329. Kliya, M. O., and G. G. Lemmlein. CHANGE IN FORM OF LIQUID INCLUSIONS WITH CHANGE IN TEMPERATURE: Soviet Physics - Crystallography [Kristallografiya], v. 3, no. 2, p. 202-205, 10 illus. on 3 figs., March-Apr. 1958, pub. 1959, 3 refs.

A microcinematographic study has been made of the processes of the change in form of liquid inclusions in sodium nitrate crystals occurring on abrupt change in temperature. It is shown that when heated to 300°C., the volume of the cavity of the inclusion and the quantity of dissolved matter increase several fold. On rapid cooling of the specimens, inclusions of nonequilibrium form are produced, which contain a gaseous phase. The results are compared with the results of observations on "high-temperature" inclusions in natural crystals. --Auth.

8. MINERALOGY AND CRYSTALLOGRAPHY

See also: Geomorphology 1-2216; Geochemistry 1-2319, 1-2329; Igneous and Metamorphic Petrology 1-2354; Sedimentary Petrology 1-2367, 1-2368.

1-2330. Fritzen, Dorothy K. THE ROCK-HUNTER'S FIELD MANUAL; A GUIDE TO IDENTIFICATION OF ROCKS AND MINERALS: 207 p., illus., New York, Harper & Brothers, Feb. 1959, 9 refs.

This book presents color as the basic step toward mineral identification; it was designed primarily as a field guide for the amateur rock-hunter and prospector. There are 10 color "keys," which are a series of easily read tables. If a mineral occurs in more than one color, it is duplicated in each "key." By first determining the color of a mineral, then progressing to such other tests such as luster, streak, hardness, weight, and cleavage, it is possible for a beginner to identify his specimen.

The Rock-Hunter's Field Manual is written in layman's language and is divided into 2 parts: Pt. I covers the definitions of rocks and minerals, equipment needed, and a brief description of the formation and appearance of the rocks in which minerals are found. Pt. II covers the determination of the physical properties of minerals, the color keys, illustrations, and a mineral section which lists the minerals in alphabetical order and gives information as to use, scope of colors, crystals, and occurrence. The minerals listed in the color keys and the mineral section are cross-filed for each reference. --Auth.

1-2331. Pearl, Richard M. 1001 QUESTIONS ANSWERED ABOUT THE MINERAL KINGDOM: 326 p., illus. (part col.), diags., New York, Dodd, Mead & Company, 1959, 54 refs.

A book for the general reader, asking and answering questions on the scientific, industrial and commercial, cultural, and hobby aspects of minerals and rocks. The book is divided into the following chapters: minerals and crystals, igneous rocks, meteorites, sedimentary rocks, metamorphic rocks, precious metals, base metals, iron and ferroalloy metals, rare and unusual metals, radioactive minerals, gems, industrial minerals and rocks, fossil fuels, mining and milling, water resources, mineral collecting as a hobby. --A. C. Sangree.

1-2332. Parrish, William, and K. Lowitzsch. GEOMETRY, ALIGNMENT AND ANGULAR CALIBRATION OF X-RAY DIFFRACTOMETERS: Am. Mineralogist, v. 44, no. 7/8, p. 765-787, 2 illus., 5 diags., 4 graphs, July-Aug. 1959, 27 refs.

The counter tube X-ray diffractometer is widely used both for routine and complicated mineralogical analyses. Very little has been published on the principles and techniques of diffractometry, and consequently many of the instrumental factors which have a profound effect on the data are often overlooked. This paper describes a rapid, precise, and reproducible method for the alignment and angular calibration of the goniometer. Simple mechanical devices are employed. The alignment, the zero angle determination to a precision of approximately $\pm 0.001^{\circ}\ 2\theta$, the precise setting of the 2:1 angular relationship between the receiving slit and the specimen surface and the adjustment of anti-scatter slits can be completed in about one hour. The method makes it possible to achieve optimum performance and to compare data with other diffractometers aligned in the same manner. The geometry, the effects of the more important instrumental and specimen factors, and some performance tests are outlined. --Auth.

1-2333. Droste, John B., and Ralph E. Grim. A CONTINUOUS X-RAY INVESTIGATION USING AN AUTOCLAVE OF THE CONVERSION OF GYPSUM TO HEMIHYDRATE: Am. Mineralogist, v. 44, no. 7/8, p. 731-737, 2 illus., 4 graphs, July-Aug. 1959, 3 refs.

An autoclave fitting into an X-ray spectrometer diffraction unit permitting continuous X-ray diffraction studies at moderately elevated temperatures and steam pressures is described. The instrument is used for the study of the conversion of gypsum to hemihydrate. Temperature and steam pressure conditions necessary and favorable for the conversion are given, and it is suggested that there is no intermediate step in the transition. --Auth.

1-2334. Flinter, B. H. THE MAGNETIC SEPARATION OF SOME ALLUVIAL MINERALS IN MALAYA: Am. Mineralogist, v. 44, no. 7/8, p. 738-751, 2 diags., graph, 9 tables, July-Aug. 1959, ref.

This paper presents the results of a series of magnetic separations which have been investigated for a number of minerals occurring in Malayan alluvial concentrates. The purpose of the investigations was to establish, by the isolation of individual mineral species, a reproducible and reliable method for the identification and quantitative estimation of minerals in alluvial concentrates examined by the Geological Survey in Malaya. In particular was sought the isolation of columbite from ubiquitous ilmenite. All the separations were made on the

small, highly sensitive Frantz Isodynamic Model L-1 laboratory separator. The minerals which have been successfully separated include allanite, anatase, andalusite (and chiastolite), arsenopyrite, brookite, cassiterite, columbite, epidote, gahnite, garnet (pink), ilmenite, manganese oxide (51.6% Mn), monazite, pyrite, rutile, scheelite, siderite, staurolite, thorite, topaz, tourmaline, uranoan monazite, wolframite, xenotime, and zircon. --Auth.

1-2335. Kamb, W. Barclay. THEORY OF PREFERRED CRYSTAL ORIENTATION DEVELOPED BY CRYSTALLIZATION UNDER STRESS: Jour. Geology, v. 67, no. 2, p. 153-170, 2 diags., 4 tables, March 1959, 14 refs.

The thermodynamic theory of equilibrium under nonhydrostatic stress, developed by Gibbs, is applied to linearly elastic crystals under infinitesimal strain and is worked out in detail for several examples of practical importance, mostly situations of uniaxial stress. The conditions for preferred orientation are shown to depend only on the stress deviators and are thus invariant to a change in hydrostatic pressure. For equilibrium across a given interface between crystal and fluid, the preferred crystal orientation under any nonhydrostatic stress is in most cases that for which the elastically weakest direction in the crystal is perpendicular to the interface. When recrystallization takes place by solution and redeposition, the preferred orientation is that which minimizes the chemical potential required for equilibrium across the plane normal to the greatest principal pressure axis. Thus the weakest axis of a crystal (c-axis of calcite) tends to align with the greatest principal pressure axis, or axes, while the strongest axis (c-axis of quartz) tends to align perpendicular thereto. Hexagonal and rhombohedral crystals are classified into 4 types on the basis of the c-axis preferred orientation expected to develop under uniaxial stress. Quartz is unique among the common hexagonal and rhombohedral minerals in that the theory predicts that under some conditions a small girdle of quartz c-axes should develop about the unique stress axis. The theory accounts for several main features of quartz fabrics observed in tectonites. An isometric crystal in a uniaxial stress field tends to align either [100] or [111] parallel to the unique stress axis (whether tensional or compressional), depending on how the crystal deviates from elastic isotropy.

When recrystallization takes place without solution and deposition, that is, by the growth of some crystals directly at the expense of adjacent ones of the same composition, an extension of Gibbs's theory is necessary to predict the preferred orientation that develops. It is found that if the initial grain shapes are equant, the condition for preferred orientation is obtained simply by averaging the conditions given by Gibbs's theory for the 3 principal stress planes. Rhombohedral or hexagonal crystals in a uniaxial stress field develop preferentially in most cases with their weakest axis perpendicular to the unique stress axis (whether tensional or compressional) or their strongest axis parallel to the unique axis. For recrystallization of glacier ice in situ during glacier flow, the theory predicts, under the likely assumption that s_{44} for single ice crystals is relatively large, several main features of the observed c-axis fabrics of temperate glacier ice. --Auth.

1-2336. Frueh, Alfred J., Jr. THE CRYSTALLOGRAPHY OF PETZITE, Ag_3AuTe_2: Am. Mineralogist, v. 44, no. 7/8, p. 693-701, 6 illus., 2 diags., 3 tables, July-Aug. 1959, 9 refs.

From small single crystals of petzite found intimately intergrown with hessite (Ag_2Te) from Bótes, Transylvania [Romania], the space group was determined to be cubic, $I4_132$ with a cell edge of 10.38 Å. There are 8 (Ag_3AuTe_2) per cell, and the atoms are located on the following special positions: 24 Ag atoms on x, 0, 1/4, etc. with x = .365; 8 Au atoms on 1/8, 1/8, 1/8, etc.; 16 Te atoms on x, x, x, etc. with x = .266.

The powder diffraction record of a high temperature form of petzite was obtained, and the material was observed to return to the low form upon rapid cooling. Heating experiments indicate some hessite-petzite solid solubility above 250° C. --Auth.

1-2337. Clark, Joan R., and C. L. Christ. STUDIES OF BORATE MINERALS (V): REINVESTIGATION OF THE X-RAY CRYSTALLOGRAPHY OF ULEXITE AND PROBERTITE: Am. Mineralogist, v. 44, no. 7/8, p. 712-719, 5 tables, July-Aug. 1959, 7 refs.

Ulexite and probertite crystals have been examined by X-ray precession methods and earlier findings confirmed. Revised data for the crystallographic elements are as follows: ulexite, $NaCaB_5O_9 \cdot 8H_2O$, triclinic $P1 - C_i^1$, $a = 8.80_9 \pm 0.02$, $b = 12.86 + 0.04$, $c = 6.67_8 + 0.02$ Å, $\alpha = 90^{\circ}15'$, $\beta = 109^{\circ}07'$, $\gamma = 105^{\circ}06'$ (all +05'); probertite, $NaCaB_5O_9 \cdot 5H_2O$, monoclinic $P2_{1/a} - C_{2h}^5$, $a = 13.43 + 0.04$, $b = 12.57 + 0.04$, $c = 6.58_9 \pm 0.02$ Å, $\beta = 100^{\circ}15' \pm 05'$. X-ray powder patterns of both minerals have been indexed, and all calculated interplanar spacings are given for $d > 2.5$ Å. --Auth.

1-2338. Eliseev, E. N. NEW DATA ON THE CRYSTAL STRUCTURE OF OLIVINE: Soviet Physics - Crystallography [Kristallografiya], v. 3, no. 2, p. 163-170, 6 figs. incl. illus., graph, 3 tables, March-Apr. 1958, pub. 1959, 23 refs.

Olivine $(Mg, Fe)_2 SiO_4$ is a mineral of variable composition whose physical properties change with change in the Mg/Fe ratio (refractive indices, birefringence, axial angle and specific gravity). According to the published chemical analyses, olivine contains insignificant amounts of impurities (Ca, Al, Mn, Cr, etc.) which cannot affect its physical properties, which are determined mainly by the isomorphous substitution of Fe for Mg.

The author investigated the dependence of the dimensions of the unit cell of olivine on the degree of isomorphous substitution and temperature.

The samples analyzed by X-ray diffraction were natural olivine (0.4-10, 13-14, 17-18, 23, 33, 40, 46, 52 and 75% Fe_2SiO_4) and fayalite from smelter slags (90% and 96-100% Fe_2SiO_4). The composition of the samples was determined by their refractive indices.

Photographs were taken by the powder method with a camera of 66 mm. radius using unfiltered Fe-radiation. The experimental error ranged from 0.05 to 0.15%. --Auth. introd.

1-2339. Seki, Yôtarô. RELATION BETWEEN CHEMICAL COMPOSITION AND LATTICE CONSTANTS OF EPIDOTE: Am. Mineralogist, v. 44, no. 7/8, p. 720-730, fig., 6 tables, July-Aug.

1959, 12 refs.

Chemical, optical and X-ray data on 5 members of the clinozoisite-pistacite series are presented. The unit cell becomes larger with increasing ferric Fe content. It is shown that the members of the clinozoisite-pistacite series can be readily distinguished from zoisite by the X-ray powder method. --Auth.

1-2340. Norton, Dorita A., and Walter S. Clavan. THE OPTICAL MINERALOGY, CHEMISTRY, AND X-RAY CRYSTALLOGRAPHY OF TEN CLINOPYROXENES FROM THE PENNSYLVANIA AND DELAWARE PIEDMONT PROVINCE: Am. Mineralogist, v. 44, no. 7/8, p. 844-874, 2 diags., 9 graphs, 18 tables, July-Aug. 1959, 13 refs.

Chemical, X-ray crystallographic, and optical properties of 10 clinopyroxenes from rocks characteristic of the Pennsylvania and Delaware piedmont province have been determined and are reported in tabular form. Theoretical considerations and the presence of persistent unidentified reflections on diffractometer curves suggest that chemically complex clinopyroxenes are substructurally different from diopside. Differences between observed optical properties and properties predicted from chemical composition are due to differences between assumed and actual amounts of minor oxides present.

Geochemical relationships between clinopyroxenes and their coexisting orthopyroxene indicate that the samples studied here are of igneous origin. Subsequent metamorphism may have resulted in the introduction of Mg, the modification of pyroxene properties, and the establishment of equilibrium between pyroxene pairs. --Auth.

1-2341. Kolesova, V. A. INFRARED ABSORPTION SPECTRA OF THE SILICATES CONTAINING ALUMINUM AND OF CERTAIN CRYSTALLINE ALUMINATES: Optics & Spectroscopy [Optika i Spektroskopiya], v. 6, no. 1, p. 20-24, 3 figs., 2 tables, Jan. 1959, 20 refs.

Infrared absorption spectra of the following 13 crystals were investigated in the 410-1,200 $cm.^{-1}$ region: corundum Al_2O_3, gallium oxide Ga_2O_3, hydrargillite $Al(OH)_3$, sodium aluminate $NaAlO_2$, albite $Na(AlSi_3O_8)$, orthoclase $K(AlSi_3O_8)$, leucite $K(AlSi_2O_6)$, nepheline $NaAlSiO_4$, cyanite Al_2O_6, α-spodumene $LiAl(Si_3O_8$, β-spodumene $Li(AlSi_2O_6)$, jadeite $NaAlSi_2O_6$, and grossularite $Ca_3Al_2(SiO_4)_3$.

It is shown that in the spectra of aluminates and aluminum silicates in which the atoms of Al are in the anion shell, there is a band in the 720-780 $cm.^{-1}$ region, hypothetically attributed to the vibrations of the Al-O bonds. --Auth.

1-2342. Kulbicki, Georges. HIGH TEMPERATURE PHASES IN SEPIOLITE, ATTAPULGITE AND SAPONITE: Am. Mineralogist, v. 44, no. 7/8, p. 752-764, 9 figs. incl. 5 diags., table, July-Aug. 1959, 16 refs.

The high temperature reactions of sepiolite, attapulgite, and saponite were studied by continuous high temperature X-ray diffraction techniques.

The easy formation of enstatite from the fibrous minerals is explained by structural analogy. The reactions of the well-crystallized specimens of sepiolite and attapulgite differ somewhat from those of their massive sedimentary varieties. The differences cannot be explained with the chemical and structural data, suggesting possible variations in some intimate details of the framework of these 2 varieties. --Auth.

1-2343. Coleman, Robert G. NEW OCCURRENCES OF FERROSELITE ($FeSe_2$): Geochim. et Cosmochim. Acta, v. 16, no. 4, p. 296-301, table, July 1959, 11 refs.

Iron selenide from the U-V ores of the Colorado Plateau was under investigation when ferroselite was described as a new mineral in Russia by Buryanova and Komkov (1955). Association of ferroselite with selenian pyrite and marcasite within discrete areas of these U-V deposits suggests an unusual environment of formation. Its association with apparent low temperature assemblages in the United States and Russia indicates that its minimum temperature of formation is quite low. Chemical analyses of ferroselite agree well with the theoretical formula $FeSe_2$; material from the Virgin no. 3 mine, Montrose County, Colorado, gives the formula $FeSe_{2.07}$ and that from the A. E. C. no. 8 mine, Temple Mountain, Utah, gives the formula $(Fe, Co)Se_{2.08}$. The similarity of hastite and ferroselite suggests that a complete series $FeSe_2$-$CoSe_2$ may exist. In contrast to this, pyrite associated with ferroselite apparently will camouflage only 4% (molecular) $FeSe_2$ within its structure. Ferroselite cannot be distinguished from rammelsbergite ($FeAs_2$) by X-ray or in polished section; therefore, the exact identification of these 2 minerals can be made only by specific tests for As or Se. As hastite ($CoSe_2$) and marcasite are in the same structure group as ferroselite and rammelsbergite, identification of these minerals should include qualitative chemical determinations. --Auth.

1-2344. Mitchell, Richard S. JAROSITE FROM NATRONA COUNTY, WYOMING: Rocks & Minerals, v. 34, no. 7/8, p. 303, table, July-Aug. 1959, 3 refs.

Earthy yellow coatings of jarosite occur on dark-gray shale near Goose Egg, Natrona County, Wyoming approximately 10 mi. SW. of Casper. Identity was determined by X-ray powder methods and by qualitative blowpipe tests. Approximate hexagonal cell constants are given. Brief but succinct details are furnished on the geological setting and the mineralogy of the occurrence. --J. Sinkankas.

1-2345. Hamilton, Howard V. VARISCITE AND ASSOCIATED MINERALS OF CLAY CANYON, UTAH: Mineralog. Soc. Utah, Bull., v. 9, no. 1, p. 13-17, 3 illus., chart, March 1959, 8 refs.

Clay Canyon, Utah, in the southern end of the Oquirrh Range, 5 mi. W. of Fairfield, is a famous source of fine variscite and a unique assemblage of phosphate minerals. A description of the 14 phosphate minerals occurring in the area is given to assist mineral collectors. --M. Russell.

1-2346. Volborth, A. STRONTIAN METAAUTUNITE FROM THE DAYBREAK MINE, MT. SPOKANE, WASHINGTON: Am. Mineralogist, v. 44, no. 7/8, p. 702-711, 5 tables, July-Aug. 1959, 26 refs.

Chemical analysis, X-ray, and optical data of

meta-autunite from Daybreak Mine, near Mt. Spokane, Wash., are compared with previous data on meta-autunite. It is shown that Mt. Spokane meta-autunite represents a very pure material with properties close to the theoretical with the exception of the Sr content. According to the analysis the composition of Mt. Spokane meta-autunite corresponds with the formula proposed by Beintema - $Ca(UO_2)_2(PO_4)_2 \cdot 6\ 1/2\ H_2O$. --Auth.

1-2347. Grametbaur, Agnes B. SELECTED BIBLIOGRAPHY OF ANDALUSITE, KYANITE, SILLIMANITE, DUMORTIERITE, TOPAZ, AND PYROPHYLLITE IN THE UNITED STATES: U. S. Geol. Survey, Bull. 1019-N, p. 973-1046, July 1959.

The bibliography is a compilation of 566 references on the kyanite, or sillimanite, group of minerals and pyrophyllite to Dec. 31, 1958. The publications are listed alphabetically by author (or authors) with full title and publication data. A brief description of the occurrence of the minerals in the United States and their uses precedes the bibliography.

The index is arranged alphabetically by mineral. Under each mineral the index is further subdivided by geographic areas (state and county) and by subjects, which include general, geology, mineral synthesis, occurrence (geographic), and technology and uses.

A complete list of periodicals and serials examined and a map of the United States, showing the location of major deposits of the kyanite group of minerals and pyrophyllite, are included. --Auth.

1-2348. McBurney, T. C., and Joseph Murdoch. HAIWEEITE, A NEW URANIUM MINERAL FROM CALIFORNIA: Am. Mineralogist, v. 44, no. 7/8, p. 839-843, 3 tables, July-Aug. 1959.

A hydrous calcium uranium silicate, found near the Haiwee Reservoir in the Coso Mountains, California, has been determined as a new mineral and named haiweeite, from the locality.

It occurs as spherulitic aggregates, or single flakelike grains, on fracture surfaces in granite and in voids of the adjacent lake bed deposits. It is pale yellow to greenish yellow in color; hardness 3.5; specific gravity 3.35; luster pearly. A chemical analysis gives it the following formula: $CaO \cdot 2UO_3 \cdot 6SiO_2 \cdot 5H_2O$. Optically it is biaxial negative, with 2V about 15°; the acute bisectrix is nearly normal to the broad surface of the bladelike grains {100}. Dispersion is strong, with $r \rightarrow v$. The spherules from the granite are in general made up of 2 components, of which the inner has higher indices of refraction, and may be considered to be metahaiweeite. The outer shell is made up of haiweeite, with indices α 1.571, β 1.575, γ 1.578.

X-ray study of minute flakes shows that the mineral is monoclinic(?) with the following (approximate) cell-dimensions:

$a_o = 15.4$ Å $b_o = 7.05$ Å $c_o = 7.10$ Å $\beta = 107°52'$

Space is probably $P2/c$ —C_{2h}^4. --Auth.

1-2349. Gillery, F. H. ADSORPTION-DESORPTION CHARACTERISTICS OF SYNTHETIC MONTMORILLONOIDS IN HUMID ATMOSPHERES: Am. Mineralogist, v. 44, no. 7/8, p. 806-818, 18 graphs, 5 tables, July-Aug. 1959, 6 refs.; also pub. as: Pennsylvania State Univ., College of Mineral Industries, Contr. no. 58-14.

A systematic study of the desorption characteristics of synthetic Na- and Ca-beidellites and saponites with various exchange capacities has been made. The results show that well-defined hydrates exist over certain ranges of water vapor pressure and that between these ranges mixed layers of the hydrates predominate. The valence of the interlayer cation has a greater effect on the desorption characteristics than the exchange capacity or the type of montmorillonoid examined. --Auth.

1-2350. Koizumi, Mitsue, and Rustum Roy. SYNTHETIC MONTMORILLONOIDS WITH VARIABLE EXCHANGE CAPACITY: Am. Mineralogist, v. 44, no. 7/8, p. 788-805, 6 figs. incl. 3 illus., 2 graphs, diag., 6 tables, July-Aug. 1959, 16 refs.; also pub. as: Pennsylvania State Univ., College of Mineral Industries, Contr. no. 58-73.

An attempt has been made to resolve the questions: 1) do montmorillonoids exist with widely varying exchange capacities; 2) which of these phases are stable under given conditions of pressure and temperature?

Two series of gels have been prepared in the saponite and beidellite regions respectively, and reacted in sealed inert systems over the range 200°-850°C. at 1,000 atmospheres water pressure. The effects of temperature, time, open or closed systems, etc. have been evaluated. In a time period which is demonstrated to be considerably longer than necessary for the completion of crystallization (as shown by a time-crystallinity study) beidellites can be synthesized with exchange capacities varying from 1/2N to over 2N (where N represents the "ideal" exchange capacity of about 90 m. eq. of the formula $Na_{.33}Al_2Al_{.33}Si_{3.67}O_{10}OH)_2$. These phases are homogeneous and all expand to 17 Å with glycol, the 2N exchange capacity members being the best crystallized. At 300° C. these phases persist for weeks at 1,000 atm. and are probably stable. With increasing temperatures only the "N" composition remains single phase up to 425°C.

The range of saponites that can be formed is much narrower. Only the N and 2N members can be prepared as single phases with a stability maximum of about 550°C. Above this temperature a new montmorillonoid (probably a Na-hectorite) is formed and this phase is stable up to 850°C. at 1,000 atmospheres.

Cation exchange capacity measurements made by X-ray fluorescence on these Mn-saturated clays shows good correlation with expected values on a relative scale. A wide latitude in compositions for stable montmorillonoid formation is thus established, especially in the beidellite family. The properties of both low c. e. c. and high c. e. c. members should be of interest.

Two other new phases corresponding to a pure magnesian stilpnomelane and a 14 Å "aluminum chlorite" are encountered in this study. --Auth.

1-2351. Lasmanis, Ray. THE MINERALOGY OF MOSELLE MINE NO. 10: Rocks & Minerals, v. 34, no. 7/8, p. 331, 341, July-Aug. 1959.

A brief account is furnished of the mineralogy, genesis and geology of the Fe ores of the Moselle Mine No. 10 in the Rolla quadrangle, Phelps County, Missouri. The deposit was initially mined for

hematite near the surface and for pyrite at depth. The latter mineral was deposited in a sink structure in limestone along with marcasite and secondary calcite, quartz, jasper, goethite, selenite, dolomite, malachite, melanterite, copiapite, and chalcanthite. --J. Sinkankas.

9. IGNEOUS AND METAMORPHIC PETROLOGY

See also: Areal and Regional Geology 1-2201, 1-2202.

1-2352. Barth, Tom. F. W. PRINCIPLES OF CLASSIFICATION AND NORM CALCULATIONS OF METAMORPHIC ROCKS: Jour. Geology, v. 67, no. 2, p. 135-152, 3 diags., 16 tables, March 1959, 12 refs.

Cata-, meso-, and epinorms are proposed for metamorphic rocks. The catanorm is essentially the C. I. P. W. norm calculated on the basis of molecular percentages and applied to high-grade metamorphic rocks. The mesonorm, which reflects mineral associations of metamorphic rocks of the mesozone, is a new norm. Rules for its calculation are presented in detail. The epinorm is outlined briefly. Quantitative chemico-mineralogical classification of metamorphic rocks can be achieved by recalculating chemical analyses of metamorphic rocks into the "standard" minerals of these metanorms. --Auth.

1-2353. Huang, W. T. PALAGONITE TUFF FROM ALPINE, WEST TEXAS: Texas Jour. Sci., v. 11, no. 2, p. 207-211, 2 illus., June 1959, 6 refs.

Tertiary palagonite tuff occurs in an area about 2 mi. SW. of Miles Pierce Ranch, between 2 syenite intrusives, 21 mi. SE. of Alpine, Texas. It consists of palagonite mixed with opaline matrix, tourmaline, and zeolites. Alteration products are analcime and laumontite. The tuff is a hydrothermally altered basalt. --M. Russell.

1-2354. DeVore, George W. ROLE OF MINIMUM INTERFACIAL FREE ENERGY IN DETERMINING THE MACROSCOPIC FEATURES OF MINERAL ASSEMBLAGES. I. THE MODEL: Jour. Geology, v. 67, no. 2, p. 211-227, 5 figs. incl. 4 graphs, March 1959, 45 refs.

The interfacial or grain boundary free-energy contribution to mineral interrelationships is largely ignored in the petrologic literature. Although only a small part of the total energy of the system, the interfacial free energy could play a dominant role during nucleation, crystal growth, exsolution, replacement, and diffusion transfer - processes that largely involve surface phenomena. By effectively determining the saturation point of the disperse phase, the nucleation sites, nucleation frequency, grain form, extent of individual grain growth, and, for certain systems, modal composition for the mineral assemblage could be determined by the minimum interfacial free energy of the system.

Because of a continuously changing environment about a grain during its growth (caused by any grain boundary strain or orientation and/or compositional differences of the adjacent grains or phases), the average interfacial free energy associated with the grain and its associated grains must continuously increase, so that a continuous increase in the effective concentration of the disperse phase is required to support further growth, especially in systems of heterogeneous nucleation. In certain systems this increase in interfacial free energy could result in a maximum grain association limit for the growing grain if the concentration required for its further growth is higher than required to precipitate the material as a separate group of grains, such as in veins of the phase.

Relative grain sizes, grain distributions, extent of various grain associations, and nature of grain contacts are interpreted as an expression of a minimum interfacial free energy of the mineral assemblage. A mechanism by which the influence of the interfacial free energy on the crystallization of a grain assemblage could be made significant is discussed in terms of a nucleation - crystal-growth model. --Auth.

1-2355. Hamilton, Warren B. CHEMISTRY OF GRANOPHYRES FROM WICHITA LOPOLITH, OKLAHOMA: Geol. Soc. America, Bull., v. 70, no. 8, p. 1119-1125, 2 diags., 2 tables, Aug 1959, 10 refs.

Four new analyses of granophyres from the Wichita lopolith of southeastern Oklahoma are presented, together with 3 analyses published previously. The silicic rocks are strongly alkaline. Relative to calc-alkaline rocks, they are low in Al_2O_3 and CaO, and high in Fe. The molecular proportion of Al_2O_3 is the same or less than the total of CaO and alkalis. The granophyres are similar to those of other big lopoliths and quite unlike calc-alkaline granites and rhyolites in composition. --M. Russell.

1-2356. Moore, James G. THE QUARTZ DIORITE BOUNDARY LINE IN THE WESTERN UNITED STATES: Jour. Geology, v. 67, no. 2, p. 198-210, map, 11 diags., 2 tables, March 1959, approx. 140 refs.

Compilation of geologic mapping and study of chemical analyses of Mesozoic and Cenozoic granitic rocks in the western United States show that there is a relation between the composition and the geographic distribution of the rocks. Rocks of the western zone are dominantly quartz diorite; rocks of the eastern zone are dominantly quartz monzonite and granodiorite. The line separating these 2 zones is called the "quartz diorite boundary line" and is traced on a map. The line crosses the Washington-Canadian border near the 120th meridian, strikes SE. through the western margin of the Idaho batholith, swings around to a SW. trend across eastern Oregon, strikes S. through California, remaining in the western margin of the Sierra Nevada batholith. The contrasting compositions of granitic rocks in the 2 zones is believed to be inherited from contrasting compositional differences in the crust existing before emplacement of the granitic rocks. --Auth.

1-2357. Ruckmick, John C., and James A. Noble. ORIGIN OF THE ULTRAMAFIC COMPLEX AT UNION BAY, SOUTHEASTERN ALASKA: Geol. Soc. America,

Bull., v. 70, no. 8, p. 981-1017, 5 figs. incl. illus., chart, 2 diags., 4 pls. incl. fold. geol. map scale approx. 2 in. to 1 mi., fold. secs., 3 tables, Aug. 1959, 48 refs.

An ultramafic complex at Union Bay, in southeastern Alaska, is an exceptionally well-exposed example of a series of similar complexes forming a belt parallel to the Coast batholith.

A body of gabbro, approximately circular in plan and about 6 mi. in diameter, intrudes folded sedimentary rocks of probably Triassic and Cretaceous age. A moderately low grade of regional metamorphism in the sedimentary rocks is increased to almandite-zone grade adjacent to the gabbroic contact. Intrusive into the gabbro is a remarkable ultramafic complex which comprises a vertical pipe approximately 1 mi. in diameter, to which is attached a lopolithic offshoot approximately 5 mi. long and 3 mi. wide. The ultramafic units range through hornblende pyroxenite, pyroxenite, olivine pyroxenite, peridotite, and dunite, and both the pipe and the lopolith show a well-developed concentric zoning with dunite in the center and pyroxenite or hornblende pyroxenite on the periphery. Magnetite is a primary constituent of the pyroxenite unit.

The most plausible explanation of the structure and petrology of the ultramafic complex is a hypothesis of successive injections of an ultramafic magma changing in composition with time and intruded in reverse of the order of crystallization of the component minerals. It has not been possible to explain the gabbro (which is olivine-free) by the same mechanism, yet the space and time relationships here, as elsewhere in the world, are probably not accidental. It is proposed, therefore, that a body of gabbro was emplaced, and into this was injected a plug and associated lopolith first of diopside-magnetite magma with minor olivine, then diopside-olivine magma, and finally olivine magma, each new magma intruding the central, incompletely solidified portion of the earlier magma. Minor mixing and melting explain the composition and distribution of the intermediate units of the complex. Lack of contact metamorphism of grade that might be expected to accompany intrusions of such high temperature is explained first by the fact that the ultramafic magmas were almost everywhere in contact with gabbro, not sedimentary rocks, and second by the fact that, being anhydrous, the ultramafic magmas absorbed, rather than expelled, volatiles.

The only likely source for magmas of these compositions would be melting portions of the mantle, but no proposed mechanism for supplying the energy for this process is suggested herein. With an available source of energy, however, it can be postulated that magmas would be generated in the succession proposed. The gabbroic magma probably would originate as a result of melting at a shallower level. --Auth.

1-2358. Lovering, J. Kerry, and Cordell Durrell. ZONED GABBRO PEGMATITES OF EUREKA PEAK, PLUMAS COUNTY, CALIFORNIA: Jour. Geology, v. 67, no. 3, p. 253-268, 12 illus. on 4 pls., 2 maps, 2 charts, May 1959, 21 refs.

A gabbro-pyroxenite-peridotite complex of probable Permian age intruded metarhyolite, also of probable Permian age. A fine-grained quartz-bearing margin of the gabbro against metarhyolite probably resulted from slight contamination and chilling. Zoned pegmatites that are closed bodies of random distribution and of varied size and shape occur in the pyroxenite. Typically, they have an outer zone of coarse augite, a middle zone of coarse augite and plagioclase, and an inner zone of finer grained myrmekitic intergrowth of quartz and albite. Consolidation was from the margin toward the center. Quartz-diorite-aplite dikes cut the gabbro, pyroxenite, and pegmatites. Regional metamorphism of chlorite grade and late Jurassic age affected the region. It is shown that the pegmatites cannot have been metamorphic in origin, nor can they have been derived from xenoliths. It is concluded that they are of igneous origin and that they reflect the normal differentiation sequence of the intrusive complex.

Residual liquid disseminated through the pyroxenite, and, enriched in volatiles, gathered into pockets in the crystal mush and crystallized, with further differentiation, to form the zoned pegmatites. The first product was the outer zone of coarse augite. This was followed by the middle zone of coarse augite and plagioclase, and in some instances with hornblende and biotite. The remaining liquid, further enriched in water and alkalis, crystallized to quartz and albite in myrmekitic intergrowth. Paulopost alteration converted plagioclase to muscovite and epidote. --Auth.

1-2359. Engel, Celeste G. IGNEOUS ROCKS AND CONSTITUENT HORNBLENDES OF THE HENRY MOUNTAINS, UTAH: Geol. Soc. America, Bull., v. 70, no. 8, p. 951-980, map, sec., diag., graph, 16 tables, Aug. 1959, 28 refs.

The dominant intrusive igneous rock in the Henry Mountains is diorite porphyry. This rock is chemically and mineralogically monotonous through the stocks, laccoliths, bysmaliths, and dikes. The aggregate volume exceeds 16 cu. mi. Locally the diorite porphyry is cut by and grades into monzonite porphyry which is more variable in composition but constitutes only 5% of the exposed rock.

Most hornblende phenocrysts in the diorite porphyry are also chemically alike, with molecular proportions of FeO/MgO of about 0.9 to 1.1. In one coarse-grained laccolith the large hornblende phenocrysts have a molecular proportion of FeO/MgO of about 0.4. This more magnesian hornblende is compositionally similar to most hornblendes from the hornblendite and amphibolite inclusions in the diorite porphyry.

Except for relatively high Na content, the diorite porphyry of the Henry Mountains could have been derived by the tapping of the upper portions of a typical andesitic parent magma from which early formed crystals of hornblende and pyroxene have settled. The monzonitic variant appears to represent a differentiate of the diorite. The inclusions are interpreted to be early formed mafic hoods or crystal segregates from the parent magma. Possibly, however, they are xenoliths of amphibolite or basaltic crust. --Auth.

1-2360. Fourmarier, Paul. THE IMPRECISION OF A COMMON GEOLOGIC TERM. Translated by P. F. Moore: Internat. Geology Rev., v. 1, no. 6, p. 88-89, June 1959, 5 refs.

The fissility of certain rocks can be due to schistose cleavage, pseudofoliation, or original stratification without mentioning the foliation of gneiss and mica schist. For this reason, the addition of the qualifying adjective "fissile" to the petrographic name of the sediment...is not wholly satisfying... It would be preferable to create a new word to indicate thin lamination, true stratification, produced during the course of sedimentation. [Author] proposes calling these thin beds "straticules" and the tendency to form these thin beds "straticulation." These 2 new expressions are analogous to the classic "strata" and "stratification."

The arrangement of glacial material into "varves" is an example of straticulation with its own characteristic properties. In this way, each of the fissilities of sedimentary rocks can be designated by a particular term which will prevent difficulties in interpretation of the literature. --Auth. concl.

1-2361. McIntyre, Donald D. THE HYDRAULIC EQUIVALENCE AND SIZE DISTRIBUTIONS OF SOME MINERAL GRAINS FROM A BEACH: Jour. Geology, v. 67, no. 3, p. 278-301, 2 illus., map, diag., 16 graphs, 9 tables, May 1959, 18 refs.; also pub. as: Pennsylvania State Univ., Mineral Industries Expt. Sta., Contr. 57-82.

In an attempt to evaluate the concept of hydraulic equivalence for wave-deposited material, the long axes of approximately 4,500 grains of quartz, garnet, clinopyroxene, hornblende, and hypersthene were measured; these grains represent 150 samples disposed on a 4 x 9-ft. grid from 3 layers in the upper foreshore of the beach at Lorraine, Ontario. Nine of the 15 layer grain-size distributions were essentially normal.

Analyses of variance of these size distributions, using a 2-crossed classification, indicated that the within-layer grain-size distribution patterns in the upper 2 layers were not consistent with one another. This was due to variations in hydraulic equivalence for some of the minerals which followed upon their reworking.

Theoretical and empirical hydraulic equivalent sizes were computed and compared, using both quartz and garnet as bases. The theoretical differences between means of the grain-size distributions were found by means of a hydraulic equivalence formula developed from Rubey's fall-velocity equation. This formula was $\phi_A - \phi_B = 1/X (\log_2 D_A - \log_2 D_B)$, where ϕ = mean grain size in phi units; D = density of mineral minus density of water; and X = a function of grain-size range.

The observed hydraulic equivalent sizes based on quartz for the 2 reworked layers were too low, perhaps because of selective removal of the coarser quartz grains. This latter, together with the fact that prismatic minerals such as hornblende set up size gradients not found for the other minerals, indicates that the grain-environment interaction, as well as grain density, grain size, and availability, is important in determining the interrelationship between the sizes of the different mineral grains.

The hydraulic equivalence values based on garnet, in contrast to those based on quartz, agree fairly well indicating that deposition from suspension controlled the heavy-mineral size relationships. --Auth.

1-2362. Wolf, K. H. TRANSPORTATION OF SAND GRAINS BY FLOTATION: Edmonton Geol. Soc., Quart., v. 2, no. 3, p. 1-2, Sept. 1958, pub. Feb. 1959, 2 refs.

In areas of low topography the transportation of sand by flotation may be of considerable importance. Relatively large quantities of well sorted angular quartz sand may be moved for long distances without undergoing morphological changes. This flotation phenomenon should be considered in environmental interpretations. --Auth.

1-2363. Dzulynski, S., M. Ksiazkiewicz, and Philip H. Kuenen. TURBIDITES IN FLYSCH OF THE POLISH CARPATHIAN MOUNTAINS: Geol. Soc. America, Bull., v. 70, no. 8, p. 1089-1118, 12 figs. incl. 7 maps, secs., diag., 3 tables, Aug. 1959, 40 refs.

The Polish Carpathian mountains are occupied for the greater part by rocks of the flysch type, in which graded bedding with the usual accompanying sole markings and other features of turbidites are ubiquitous. For several years Polish geologists have successfully applied the concept of turbidity flow to explain features formerly thought to be conflicting. This paper deals with paleogeographic problems and summarizes results so far attained by numerous measurements of current direction. A few separated troughs persisted throughout the Cretaceous and Paleogene sedimentary history. Each of these oblong basins had its separate history in which location and direction of supply varied greatly with time. Most units show a consistent system of transport. Dominantly lateral supply is obvious in some cases. In others the measurements indicate a distant supply and from thence longitudinal transport in the flysch trough with or without local coarse supply from the sides. However, evidence, mainly paleogeographic, strongly suggests that local cordilleras between or flanking these troughs acted as the main source. Continued field work may throw light on this controversial topic which occurs in many other geosynclines that contain turbidite formations.

A number of sedimentological problems are examined on the basis of evidence mainly from Poland: upper margins of graded beds, suspended currents, convolute lamination, doubtful turbidites, glauconite in turbidites. A few new sole markings are named and described. --Auth.

1-2364. Rech-Frollo, Marguerite. ESSENTIAL AND SPECIAL CHARACTERISTICS OF THE FLYSCH FACIES. Translated by P. F. Moore: Internat. Geology Rev., v. 1, no. 6, p. 86-87, June 1959.

Too frequently the term "flysch" has been applied to sediments which resemble, in part, flysch deposition. Flysch beds are a thick accumulation of unsorted, angular, detrital material intercalated with thin beds of pelitic limestone. It marks the termination of sedimentation in a trough or basin before emergence. Other characteristics differentiate flysch and flyschlike deposition, but most definitive is the totality of characterizing elements, rather than each individual characterizing element. --Ed. abs.

1-2365. Schneider, Horst E., and André Cailleux. SIGNIFICATION GEOMORPHOLOGIQUE DES FORMES DES GRAINS DE SABLES DES ETATS-UNIS [GEOMORPHIC SIGNIFICANCE OF

THE FORMS OF SAND GRAINS OF THE UNITED STATES]: Zeitschr. Geomorphologie, v. 3, no. 2, p. 114-125, illus., May 1959; text in French, summs. in English and German.

Percentages of unworn and variously rounded quartz grains in sands from localities in New England, the Great Lakes region, and Florida confirm previous conclusions that the nature and degree of rounding and smoothing, or their absence, are an index to the conditions of formation, whether water-worn in a marine, lacustrine, or fluvial environment, or wind-transported in the present or the geologic past. Tabulated data on the percentages of the different types of quartz grains in over 100 samples are given. --M. S.

1-2366. Charlier, Roger H., and Sheldon M. Atlas. ETUDE GRANULOMETRIQUE ET ROENTGENSCOPIQUE DES QUELQUES SEDIMENTS LITTORAUX DE LONG ISLAND, N.Y. [GRANULOMETRIC AND X-RAY STUDY OF SOME LITTORAL SEDIMENTS OF LONG ISLAND, N.Y.]: Zeitschr. Geomorphologie, v. 3, no. 2, p. 145-150, sketch maps, May 1959; text in French, summs. in English and German.

Long Island is an extension of the Atlantic Coastal Plain. Modern sediments directly overlie a southward-dipping Precambrian crystalline basement. Differences in the relief of the N. and S. shores suggested the possibility that the beach sands might exhibit corresponding variations in petrographic composition and grain size. Granulometric and X-ray analyses of samples from a series of localities confirmed the assumption. The average grain size of sands from the N. shore was found to be generally greater than 1/2 mm., for sands from the S. shore less than 1/2 mm. In addition to alpha-quartz grains, of which the S.-shore sands are almost completely composed, the N.-shore sands also contain a significant quantity of material which has not yet been identified. --M. S.

1-2367. Ljunggren, Pontus. THE BLACK BEACH SANDS OF IZTAPA ON THE PACIFIC COAST OF GUATEMALA: Kgl. Fysiog. Sällsk. Lund, Förh., v. 28, no. 11, p. 109-119, sketch map, 1958, pub. 1959,; summ. in Spanish.

The mineralogical composition of the black beach sands of Iztapa on the Pacific coast of Guatemala has been examined. The principal minerals are: olivine, quartz, augite, and hypersthene, together with fragments of the groundmass of different lavas. Only one ore mineral is found: a titaniferous magnetite. Examinations have shown that the Ti is included in the magnetite lattice, and is not present as detectable intergrowths of Ti compounds. These sands originate from the decomposition of andesitic and basaltic eruption products, derived from the central volcanic plateau of Guatemala. The possibilities of an economic utilization of the magnetite are discussed. --Auth.

1-2368. Ljunggren, Pontus. MINERALOGICAL EXAMINATION OF BLACK BEACH SANDS FROM "LAGO DE IZABAL", EASTERN GUATEMALA: Kgl. Fysiog. Sällsk. Lund, Förh., v. 28, no. 14, p. 133-139, geol. sketch map, 1958, pub. 1959.

Sand samples from 4 beaches at "Lago de Izabal" in eastern Guatemala are examined. Samples from one locality show 82.6% ilmenite; samples from the other 3 localities consist mainly of serpentine, the content of ore minerals being negligible. The possible enrichment of chromite in beach and river sands within this region is discussed. --Auth.

1-2369. Thomas, Charles W. LITHOLOGY AND ZOOLOGY OF AN ANTARCTIC OCEAN BOTTOM CORE: Deep-Sea Research, v. 6, no. 1, p. 5-15, sec., 3 graphs, 2 tables, 1959, 22 refs.

Polar deep-sea cores provide material for a thermo-time scale. An Antarctic Ocean deep-sea core from the Ross Sea can be correlated with 3 others from the same area, dated by Urry and described by Hough. All the cores showed several alternations of glacial marine sediment and of fine-grained sediment which is apparently nonglacial. Organic deposits, notably radiolarian tests, are associated with glacial marine horizons and are lacking in the nonglacial ones, thus providing a zoological criterion for correlation. This association of sediments suggests inhibition of solar energy during deposition of strata where organic remains are lacking.

For the period of sedimentation represented by the core, a record of Pleistocene and recent thermal regimen is provided. Amelioration of climates over the past 6,000 years is indicated in this record. --Auth.

11. GEOHYDROLOGY

See also: Areal and Regional Geology 1-2187, 1-2188, 1-2191, 1-2200; Geophysics 1-2314; Geochemistry 1-2325.

1-2370. Pirkle, E. C., and H. K. Brooks. ORIGIN AND HYDROLOGY OF ORANGE LAKE, SANTA FE LAKE, AND LEVYS PRAIRIE LAKES OF NORTH-CENTRAL PENINSULAR FLORIDA: Jour. Geology, v. 67, no. 3, p. 302-317, map, sec., 2 diags., graph, May 1959, 6 refs.

The water table in the Ocala limestone is the local base level of erosion in southeastern Alachua County. The basin of Orange Lake has developed in that area as a result of the erosion of insoluble sediments of the plateau and solution of the Ocala limestone to that water plane. Usually, the lake fluctuates with the water table. The lake water sometimes becomes perched when impervious lake sediments prevent loss of water through the lake bottom and solution channels into the underlying permeable limestone. This situation may develop when the water table falls during periods of diminished rainfall. The recent low stand of water in Orange Lake was caused by factors in addition to the prevailing drought conditions. The regional water table in the limestone fell below the lake bottom. This resulted in sufficient hydrostatic pressure to unlodge sediments plugging a sinkhole. The lake level subsequently fell considerably, due in large part to the quantity of water discharged into the underlying limestone through the sink.

Santa Fe Lake, located in northeastern Alachua County, is largely sealed off from the principal

aquifer, the Ocala limestone, by Pleistocene clayey sands and relatively impervious sediments of the Hawthorne formation. Sufficient rain water from the youthful plateau of pine-palmetto flatlands, swamps, and marshes slowly drains and seeps into the lake to largely offset losses from evaporation, transpiration, and seepage even during drought periods. In addition to discharge by seepage in an eastward direction through surficial sands, overflow into a swampy area N. of the lake occurs at times of unusually high water. These conditions result in a more stabilized lake level than that of Orange Lake.

Even though the Hawthorne formation and surficial sands are superimposed on the Ocala limestone in the region of Levys Prairie lakes, that part of Putnam County is a recharge area of the Eocene limestones. In this region the upper part of the Hawthorne formation contains considerable carbonate. Solution of both Hawthorne sediments and the Ocala limestone has resulted in slumpage that breached the superimposed, relatively impervious sediments, thus facilitating and, in some cases, allowing free downward movement of water to the principal aquifer, the Ocala limestone. A sink is known to connect one Levys Prairie lake with underlying pervious sediments. The lakes fluctuate markedly with periods of drought and abundant rainfall. The lower parts of this prairie surface coincide approximately with the piezometric surface of the water in the Eocene limestones. It appears that the piezometric surface in this area of subsurface drainage is acting as a temporary base level of erosion despite the surficial insoluble sediments. The topography contrasts markedly with the area of Orange Lake from which most of the insoluble materials of the plateau have been eroded away. -- Auth.

1-2371. New Mexico, State Engineer Office. HYDROLOGIC SUMMARY, NEW MEXICO STREAMFLOW AND RESERVOIR CONTENT, 1888-1954. Prepared in cooperation with the New Mexico Interstate Stream Commission and the U. S. Geological Survey: Its: Tech. Rept. no. 7, 326 p., illus., 8 maps, graphs, tables, 1959, refs.

In 1952, the New Mexico State Engineer Office and Interstate Stream Commission initiated a compilation of available hydrologic and climatological data pertaining to the New Mexico section of the Rio Grande Valley for use in litigation over interstate apportionment of the river's flow. Included were all available records of temperature, frost, evaporation, precipitation, streamflow, and reservoir content - both published and unpublished - from the beginning of record through 1952.

By 1954 the initial compilation had been completed, and it was decided to expand the work to apply to the entire State, collecting and publishing in units all data taken at each weather, river, and reservoir station from the beginning of record through 1954, thus providing convenient access to complete records for all stations. Summaries of temperature, frost, and evaporation records were published in 1956 as Tech. Rept. 5 of the State Engineer, and records of precipitation were published in 1956 as Tech. Rept. 6. In the present publication, third volume in the series, are records of streamflow and reservoir content for all stations known to have operated in New Mexico from 1888 to 1954, inclusive. Also contained are bar graphs showing the length and type of record at all stations during the period of operation. Streamflow measurements are presented on a calendar-year basis, and annual totals are included where available. Sources of all records are indicated.

The compilation contains more than 100,000 separate items of basic data for the following drainage basins: 1) Arkansas River basin, 2) Colorado River basin, 3) Pecos River basin, 4) Rio Grande basin, and 5) closed basins: Estancia Valley, Mimbres Valley, Tularosa Valley. -- From auth. introd.

1-2372. Audini, R. E., C. F. Berkstresser, Jr., and Doyle B. Knowles. WATER LEVELS IN OBSERVATION WELLS IN WISCONSIN THROUGH 1957: Wisconsin Geol. & Nat. History Survey, Inf. Circ. no. 4, 192 p., 160 illus., 1959, 17 refs.

Water-level measurements in Wisconsin were begun in a few wells in 1934. Measurements were made in 1957 in 204 observations wells in 65 counties. Local and regional variations in storage caused by changes in recharge and natural discharge and changes in pumping from wells are reflected in the fluctuations of the water levels.

Water levels are generally highest in the spring, owing to thawing of the frost zone and precipitation, after which they decline through the summer, rise slightly in the fall, and decline through the winter. In general, in areas not affected by pumping, water levels gradually rose from 1940 to 1947 and declined from 1947 to 1951. They rose again in 1951 and 1952, after which they declined through 1957.

Large declines in water levels have occurred in the heavily-pumped Milwaukee-Waukesha area, and smaller, but significant, declines have been recorded in a few other areas. In most of the state, however, water levels have not seriously declined. Even in the areas of heavy pumping, much additional ground water can be obtained from properly spaced wells. --Auth.

12. MINERAL DEPOSITS

See also: Geologic Maps 1-2156 through 1-2159, 1-2161, 1-2162; Areal and Regional Geology 1-2184, 1-2185, 1-2192, 1-2197, 1-2199, 1-2200; Geomorphology 1-2216; Geophysics 1-2284 through 1-2289, 1-2291 through 1-2310, 1-2312, 1-2313, 1-2315, 1-2316, 1-2317; Geochemistry 1-2323; Mineralogy 1-2334, 1-2347, 1-2351; Sedimentary Petrology 1-2367, 1-2368.

1-2373. Rand, John R. THE MAINE MINING LAW FOR STATE-OWNED LANDS: 16 p., fold. map, 2 pls., Augusta, Maine, Maine Geological Survey, Sept. 1959.

This booklet is the second edition of the description of Maine Mining Bureau regulations regarding exploration and development of mineral resources on state-owned lands. The booklet describes the general operation of the Mining Bureau, and discusses the revised statutes concerned with mineral development on lands under Mining Bureau jurisdiction. The booklet contains a copy of the pertinent statute, Chap. 135, Public Laws of 1959, as enacted by the 99th Legislature - An Act to Clarify the Maine Mining Law. This new act embodies several changes in the

original law, which was enacted by the 98th Legislature in 1957.

Included in the booklet are 2 full-page plates showing methods of claim staking, and a sample claim description map. There is also a back page folded index map showing the location of public lots reserved for schools which are available for mineral development under authority of the Maine Mining Bureau. --R. G. Doyle.

1-2374. Konoplyantsev, M. A. THE RELATIONSHIP BETWEEN EXPLORATION, SURVEYING, AND PROSPECTING. Translated by U. S. Joint Publications Research Service: Internat. Geology Rev., v. 1, no. 7, p. 71-74, July 1959.

The end purpose of all geologic field work in the U. S. S. R. should be the detection of useful mineral resources necessary to the Soviet national economy. At the present time, unfortunately, the numerous guides, instructions, and manuals on the methods of geologic surveying, prospecting, and exploration do not clearly define the nature and tasks of each form of geologic investigation. The various guides, at times, overemphasize their own discipline to the detriment of a related phase of geologic investigation or, conversely, so identify one discipline with another that the role of each is not quite clear.

The present practice of a large-scale survey followed by a medium-scale survey, and then by a small-scale survey is time consuming and expensive. There is no reason why a survey on a 1:200,000 or 1:100,000 scale should always be followed by a survey on a 1:500,000 or 1:25,000 scale, and only then by a survey on a 1:10,000 scale. Proper instruction of the field geologist would improve the quality of such surveys so as to insure transition to another scale without necessitating additional surveys. The field geologist would then have a greater responsibility for the quality of his work and for the care taken in prospecting in a region.

To achieve this goal it is necessary to revise all the instructions on geologic surveying, to unify all prospecting methods in these instructions, and to define accurately the role of geologic surveying in relation to prospecting and exploration. --T. F. Rafter, Jr.

1-2375. Finch, Warren I. GEOLOGY OF URANIUM DEPOSITS IN TRIASSIC ROCKS OF THE COLORADO PLATEAU REGION: U. S. Geol. Survey, Bull. 1074-D, p. 125-164, 4 illus., 4 maps (3 in pocket), cross sec., July 1959, 38 refs.

Important U deposits are widely distributed in the Triassic rocks of the Colorado Plateau region. These deposits, which have been the second most important domestic source of U in the United States, have also yielded V, Cu, and Ra during various periods of mining in the past 50 years.

Most of the deposits in Triassic rocks are in the Shinarump and Moss Back members of the Chinle formation, but some important deposits are also in other members in the lower part of the Chinle, particularly in beds within 50 ft. of the Middle Triassic unconformity. In northeastern Arizona, eastern Utah, and western Colorado 3 mineral belts have been outlined, each bounded by a pinchout. These belts, which contain about 20% of the areas underlain by the Chinle formation, are the Monument Valley belt, the E. White Canyon belt, and the Moab belt.

The chief unoxidized U minerals, uraninite and coffinite, and the oxidized U minerals, carnotite and tyuyamunite, impregnate the rocks, forming disseminated ores. Fossil wood replaced by these minerals and the associated Fe and Cu minerals constitute the high-grade ore. Most of the ore averages between 0.20 and 0.30% U_3O_8 and some ores average either between 1 and 2% V_2O_5 or between 1 and 2% Cu.

The ore bodies are irregularly distributed and form uneven tabular and concretionary masses that lie essentially parallel to the bedding of channels and lenses filled with coarse clastic material. They range in content from a few tons to more than a hundred thousand tons.

It is believed that in early Tertiary time ground water leached U and other ore metals from overlying mudstone beds or from the ore-bearing rocks themselves and redeposited the metals in favorable sedimentary and tectonic structures. --Auth.

1-2376. Cathcart, James B., and Lawrence J. McGreevy. RESULTS OF GEOLOGIC EXPLORATION BY CORE DRILLING, 1953, LAND-PEBBLE PHOSPHATE DISTRICT, FLORIDA: U. S. Geol. Survey, Bull. 1046-K, p. 221-298, index map, 19 figs. under separate cover incl. 18 cross secs., fold. diag., June 1959, 21 refs.

A program of core drilling to delimit the U- and phosphate-bearing strata (the aluminum and calcium phosphate zones) of the land-pebble phosphate district [27°-28°15'N. 81°45'-82°15'W.], and to study the stratigraphic relations of the Bone Valley formation, was carried out in the fall of 1953.

A series of cross sections, an isometric fence diagram, and a series of tables summarize the lithologic, stratigraphic, analytical, and economic data derived from the drilling.

The Bone Valley formation of Pliocene age was deposited by a transgressing sea. In most of the district, the Bone Valley overlies limestone or dolomite of the Hawthorn formation (middle Miocene); but in the northern part of the district in northern Polk County, where the Hawthorn thins to an erosional featheredge, the Bone Valley overlies the Tampa formation (early Miocene), and farther to the N., in Pasco County, clayey sand of the upper part of the Bone Valley overlies the Suwannee limestone (Oligocene). To the E. and S., however, the Bone Valley overlies unnamed sand and limestone that contains fossils of late middle Miocene age. This material in turn overlies the limestone or dolomite of the Hawthorn formation.

In the northernmost line of holes drilled, material correlated with the upper part of the Bone Valley on the basis of lithologic character overlies a sandy clay that contains angular white phosphate particles, material very similar to the hard-rock phosphate. It is thought that this material, here called Alachua(?) formation, may represent the Alachua formation. It appears, therefore, that the Bone Valley is in part equivalent to the Alachua formation, but that a part of the Bone Valley formation may be somewhat younger than the Alachua. Three holes in the NE. part of the area penetrated the Ocala limestone (Eocene). Indications are that this limestone may occupy an upthrown fault block.

After the deposition of the Bone Valley, weathering altered the formation, changing fluorapatite to wavellite and crandallite (pseudo-wavellite), and forming the aluminum phosphate zone.

In the northwestern part of the land-pebble district, the aluminum phosphate zone extends

beyond the limits of the calcium phosphate zone. To the E. and S., the calcium phosphate zone extends beyond the limits of the aluminum phosphate zone. In the northern part of the area where the phosphate deposition was thinnest the entire Bone Valley formation may have been leached, whereas to the S., where the formation was thicker, only the top part of the formation was leached, and both zones are present. Still farther to the S., in Hardee and Manatee counties, the Bone Valley formation may not have been exposed to subaerial weathering, and the aluminum phosphate zone was not formed. The present limit of the aluminum phosphate zone is the result of a combination of erosion after the zone was formed, and the possibility that to the E. and S., phosphatic sediments were not exposed to weathering in the Pliocene. The aluminum phosphate zone and the calcium phosphate zone both cut across stratigraphic units. This is clearly shown in some of the cross sections where, for example, aluminum phosphate minerals have formed in the Bone Valley, the Hawthorn, and the Tampa formations. The calcium phosphate zone may be entirely within the Bone Valley formation, entirely within the Hawthorn formation, or most commonly, it includes the bottom part of the Bone Valley, and the weathered top of the Hawthorn formation. The phosphate deposits of the land-pebble district are thus complex - partly residual, partly marine reworked, and partly phosphatized clay. --Auth.

1-2377. Overstreet, William C., Paul K. Theobald, Jr., and Jesse W. Whitlow. **THORIUM AND URANIUM RESOURCES IN MONAZITE PLACERS OF THE WESTERN PIEDMONT, NORTH AND SOUTH CAROLINA:** Mining Engineering, v. 11, no. 7, p. 709-714, map, 4 tables, July 1959, 18 refs.

Monazite placers in the western piedmont of the Carolinas, explored by the U. S. Geological Survey in 1951-1954, are estimated to contain at least 53,000 short tons of ThO_2 and 4,600 short tons of U_3O_8. None of these deposits is being mined. --Auth.

1-2378. Kepferle, Roy C. **URANIUM IN SHARON SPRINGS MEMBER OF PIERRE SHALE, SOUTH DAKOTA AND NORTHEASTERN NEBRASKA:** U. S. Geol. Survey, Bull. 1046-R, p. 577-604, 8 figs. incl. maps, secs., diags., logs, 4 pls. (in pocket) incl. 2 maps, secs., logs, 6 tables, July 1959, 34 refs.

A study of the U content of the Sharon Springs member of the Pierre shale in South Dakota and northeastern Nebraska was made in 1954. More than 300 samples of this black organic marine shale of Late Cretaceous age from 30 exposures and 2 core holes show that the U content averages about 0.0015% throughout the region studied. The most uraniferous parts are about 3 in. thick and contain as much as 0.025% U. The richest sample comes from an exposure along the Missouri River in Nebraska and is thought to be secondarily enriched by weathering. Water from the Sharon Springs member generally has a pH of less than 4, and 7 samples from seeps and springs contained from 7 to 780 parts U per billion.

The thickness of the Sharon Springs member ranges from 1 to 42 ft. in exposures along the Missouri River and is as much as 106 ft. on the eastern flank of the Black Hills. Gamma-ray logs and published lithologic logs from holes drilled for oil and gas indicate that rocks equivalent to the member extend northward from central South Dakota into North Dakota and that the radioactivity decreases northward.

Along the Missouri River in eastern South Dakota, the noncalcareous Sharon Springs member lies on the calcareous Niobrara formation. At some places the 2 units appear conformable; at others a disconformity separates them. Along the SE. flank of the Black Hills and northward to North Dakota, the Sharon Springs rests conformably on rocks equivalent to the Gammon member of the Pierre shale.

The upper boundary of the Sharon Springs member is poorly defined except at a few exposures along the Missouri River where a marly zone marks the base of the overlying Gregory member of the Pierre. Elsewhere, the upper boundary is placed at the change from the darker color and steeper slopes of the Sharon Springs member to the lighter color and gentler slopes of the overlying Gregory member.

Semiquantitative spectrographic analyses of 82 samples of black shale from the Sharon Springs member indicate that the Mo, Fe, and phosphate contents tend to vary directly with the U content, whereas the Al, Ga, B, Ti, Mg, and Na contents vary inversely with the U content.

The U in the Sharon Springs member is thought to have been emplaced during or shortly after the deposition of the shale. --Auth.

1-2379. Sullivan, John D. **IRON & STEEL: THE PALEY REPORT IN RETROSPECT:** Mining Engineering, v. 11, no. 8, p. 789-796, 2 graphs, 12 tables, Aug. 1959.

A comparison of an interpolation of statistical data on the production of ferrous materials and on the supply of iron and steelmaking raw materials with the actual values in 1957 shows that no gross errors in estimation of trends were made in the Paley Report. Differences are of degree rather than kind. There are ample supplies of iron ore, although the tonnage of pellets from the concentration of taconites and jaspers are larger than predicted. Imports from South America are large. This paper shows also the potential new supplies that may be expected from eastern Canada.

Although the Paley Report was pessimistic about the supply of obsolescent scrap, a recent report shows that the potential supply of obsolescent scrap is currently ample and sufficient for domestic needs and reasonable exports, and that it likely will be until 1975. This 1957 report points out, however, that because of the changing nature of steel production the relative amount of heavy melting scrap may be expected to decrease.

Due to technological developments, the coke supply situation appears more favorable than might be inferred from the Paley Report.

Although the report was not too concerned about the supply of additive metals, and while there was a shortage - particularly of nickel - a few years ago, the conclusions made appear to be sound, particularly since new supplies of these metals are becoming available.

Certain technological predictions made in the Paley Report are treated in detail and some issue is taken over certain estimates of adoption of certain new processes. The role of some of these methods in the present iron and steel industry is discussed.

With regard to Paley Report data on non-American industry, this paper covers the possible effect of the European Coal and Steel Community on the U. S. iron and steel industry, and statistics are given on the 6 Schuman Plan countries. Russia's role in the world picture is considered briefly. Canada is becoming one of the world's leading producers of iron ore. Production there of pig iron and steel likewise is growing. --Auth.

1-2380. Webber, Benjamin N. BAUXITIZATION IN THE POCOS DE CALDAS DISTRICT, BRAZIL: Mining Engineering, v. 11, no. 8, p. 805-809, sec., diag., 3 graphs, table, Aug. 1959, 4 refs.

During World War II the Pocos de Caldas bauxite deposits of Minas Gerais in Brazil yielded some 60,000 tons. Since then they have maintained a small but almost continuous production. Known for many years, the deposits have been reconnoitered by a number of geologists, but no dimensional study has been possible because there have not been enough exposures to show clearly the depth, bedrock, and habit of occurrence. The geologic setting, bauxite types, parent rocks, and age of deposits are covered in the article. Features conditioning bauxitization are discussed. --Auth.

1-2381. Ham, William E. NONMETALLIC MINERAL PRODUCERS IN OKLAHOMA, 1958: Oklahoma Geology Notes, v. 19, no. 7, p. 131-138, July 1959.

During 1957 approximately 135 quarries and pits in Oklahoma produced 34 million dollars worth of nonmetallic minerals. They are listed by name, location, and business address under the following generalized categories of products: cement, clay, gypsum, lime, salt, sand and gravel, silica sand, stone, sulfur, and volcanic ash. --M. Russell.

1-2382. [Kelley, Frederic R.] ADOBE BRICK: California, Div. Mines, Mineral Inf. Service, v. 12, no. 7, p. 1-6, 8 illus., 4 tables, July 1959, 11 refs.

Adobe bricks, molded of mud and dried in the sun, have long been used in hot, dry regions of the world; some in Babylonia and Egypt are well preserved after more than 3,000 years. Many of the California mission structures were built of adobe bricks, but here they were not so lasting due to the winter rains.

Moisture will penetrate a mud brick and cause it to disintegrate as the binding forces of the clay particles are released. This is avoided by a process developed recently to "stabilize" the brick by using emulsified asphalt in the mix. These waterproofed bricks have revived interest in adobe construction, with its good insulating qualities and aesthetic appeal. Design improvements, requiring less massive walls, have added to this interest.

In California, several distributors market commercially made adobe bricks. They are produced by 3 manufacturers, using special machinery and carefully controlled processes. The mass-produced bricks, of high quality, can be distributed to many areas cheaper than they could be produced at the construction site. Commercial production totals about 600,000 adobe bricks annually. --Auth.

1-2383. Lamar, J. E. LIMESTONE RESOURCES OF EXTREME SOUTHERN ILLINOIS: Illinois State Geol. Survey, Rept. Inv. 211, 81 p., 4 illus. on 2 pls., 8 maps (6 in pocket), 2 cross secs., 7 tables, 1959, 22 refs.

The 7 southernmost counties of Illinois - Alexander, Hardin, Johnson, Massac, Pope, Pulaski, and Union - contain a wide variety of limestones of Paleozoic age. Their distribution and chemical and physical character are described herein as they relate to the potential uses of the stone, with particular attention paid to their suitability for making portland cement.

The selection and evaluation of quarry sites are discussed, as are the principal uses of limestone. Limestone resources are presented by geological formation and by county. County maps show the distribution and general character of the various limestone formations. The significance of the clay and shale resources to portland cement making is briefly discussed. Results of 118 chemical analyses and 40 physical tests of limestones and of 58 chemical analyses of shales and clays are given. --Auth.

1-2384. Crosby, Garth M. THE GEM STOCKS AND ADJACENT OREBODIES, COEUR D'ALENE DISTRICT, IDAHO: Mining Engineering, v. 11, no. 7, p. 697-700, 3 maps, table, July 1959, 9 refs.

Seven mines with important production records in the Coeur d'Alene mining district are located adjacent to gem stocks - the Frisco (Gem), Hercules, Interstate, Rex (Sixteen to One), Success (Granite), Sunset and Tamarack. Old records are incomplete, but available data show these mines have produced 10,550,721 tons of ore, containing more than 50 million oz. of Ag, over 1,500,000,000 lb. of Pb and about 1 billion lb. of Zn, or approximately 1,250,000 tons of Pb and Zn combined. This impressive production record represents about 12% of the yield from the Coeur d'Alene mining district, and at present metal prices with modern beneficiation would have a gross value of $400 million. The Hercules mine alone produced one half the Pb, and the Interstate and Tamarack mines produced over one half the Zn. The Ag ratio ranges from 0.4 (oz. of Ag per unit of 20 lb. of Pb) at the Interstate and Rex mines to a high of 0.8 at the Hercules mine. The average Ag ratio for the group of mines is 0.65. The Hercules mine produced the highest grade Pb ore, its 3,500,000 tons averaging about 11% of the metal. Though the Interstate mine produced a little less than 1 million tons of ore it averaged the astonishing grade of 17.4% Zn. The average grade of ore for the group of mines is approximately 4.8 oz. of Ag per ton, 7.2% Pb, and 4.6% Zn. --Auth.

1-2385. Wilson, Stephen R. GOLD HILL, UTAH. CLIFTON DISTRICT, TOOELE COUNTY: Mineralog. Soc. Utah, Bull., v. 9, no. 1, p. 5-11, March 1959.

"The Gold Hill area, or, more specifically, the Clifton district, has had an interesting mining history, even though total ore production falls short of major district classification. The value of mineral production from discovery of the district in 1858 to the present is estimated at approximately $6,800,000. Recorded production lists ores containing Au, Ag, Cu, Pb, Zn, W, As, and Bi. In addition, minor amounts of Sb, V, Sn, and Mo occur in some of the ores. Hg ore has been mined from one property on the W. side of the Deep Creek range, a short dis-

tance S. of the Clifton district."

The geology and mineralogy of the following 19 mines of the area is given: Fraction Lode, Stardust Mines, Inc., Rube, Alvarado, Cane Springs, Gold Hill, U. S. Mine, Ida Lull, Western Utah Extension Copper Co., Success, Frankie, Lucy L., Gold Bond, Copper Bloom, Pole Star, Reaper, Yellow Hammer, Wilson Consolidated, Monocco. The known minerals of the Gold Hill area, approximately 100, are listed. --M. Russell.

13. FUELS

See also: Geologic Maps 1-2161; Areal and Regional Geology 1-2183, 1-2186; Geophysics 1-2290, 1-2311; Geochemistry 1-2324.

1-2386. Scholten, Robert. SYNCHRONOUS HIGHS: PREFERENTIAL HABITAT OF OIL?: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 8, p. 1793-1834, 8 maps, 19 secs., 5 diags., Aug. 1959, 88 refs.; also pub. as: Pennsylvania State Univ., Mineral Industries Expt. Sta., Contr. no. 58-19.

Synchronous highs are "hills" on the sea floor present during sedimentation. Their origin may be diastrophic, depositional, erosional, or inherited through compaction or draping, or a combination of these. They tend to create conditions favorable to all 3 stages in the natural history of petroleum - origin, migration, accumulation - and are therefore thought to represent preferential habitats of oil and gas. This thesis is examined in the light of various modern observations and experimental data and exemplified through published descriptions and illustrations of numerous pools. Traps of this type may possess a variety of characteristic structural, topographic, sedimentary, and stratigraphic features which may be found in some cases through field, air-photo, or geophysical methods, but more commonly through careful studies of subsurface samples and logs. --Auth.

1-2387. Frascogna, Xavier M., ed. MESOZOIC-PALEOZOIC PRODUCING AREAS OF MISSISSIPPI AND ALABAMA, VOLUME 1: 139 p., 56 maps (part fold.), secs. (2 fold.), 2 fold. logs, Jackson, Mississippi, Mississippi Geological Society, Sept. 1957, refs.

This volume was published primarily for the purpose of presenting the mass of known subsurface data related to Mesozoic-Paleozoic production in reference form for the use of those interested in the Mississippi-Alabama area. Producing fields are presented alphabetically with a structural contour map and a brief resume of pertinent subsurface data. This data gives the name of the discovery well, the oldest stratigraphic unit penetrated, nature of the trap, lithology of the reservoir rocks, type of exploration leading to discovery and production history, as well as reservoir information which includes productive area, estimated reserves, reservoir energy, initial bottom hole pressure and typical core analysis. Stratigraphic cross sections and type logs in the general producing area are included along with maps showing the relationship of the major tectonic features of the eastern Gulf Coast to the producing area. The presentation of specific field data with general geological information on the area make this attractively bound volume a very useful item for those interested in an extremely prospective and active area. --W. H. Hollingsworth.

1-2388. 1958 STATISTICS OF THE PETROLEUM INDUSTRY IN OKLAHOMA: Oklahoma Geology Notes, v. 19, no. 7, p. 140-141, July 1959, 4 refs.

Data, compiled principally from Oil and Gas Journal and World Oil, is given on drilling for, production of, and reserves of crude oil, natural gas, and natural-gas liquids of Oklahoma for 1958. --M. Russell.

1-2389. Bobrov, Yu. P. ON PROSPECTING METHODS FOR BURIED DEVONIAN UPWARPS IN THE VOLGA REGION AT SARATOV. Translated by Salih Faizi: Internat. Geology Rev., v. 1, no. 7, p. 24-29, 6 figs. incl. 3 maps, secs., July 1959, 4 refs.

Above each oil-bearing Paleozoic upwarp in the D_2-V horizon of the Givetian in the Volga region at Saratov exists a zone of differential thickness of sediment due to pre-Bajocian erosion. Determination of variation in the thickness of Devonian and Carboniferous sediments overlain by younger strata may establish the position of these upwarps. Drilling programs have been designed for paleogeologic mapping in order to locate upwarps. Study of local and regional tectonic development also discloses thickness differentials. In places where the Bajocian sediments dip gently, paleogeologic maps may be replaced by less time-consuming paleostructure maps showing thicknesses from the bottom of the oil-bearing Myachkovsk horizon to the top of the Bajocian or eroded Carboniferous surface. In some prospective oil fields, such as the Surovka, seismic survey has failed to detect Devonian terrigenous strata and, consequently, paleogeologic mapping of the pre-Bajocian erosion surface is required. --G. E. Denegar.

1-2390. Maher, T. P., Joseph M. Harris, and G. R. Yohe. ACIDIC STRUCTURAL GROUPS IN ILLINOIS COALS: VARIATION DURING OXIDATION AND CARBONIZATION: Illinois State Geol. Survey, Rept. Inv. 212, 75 p., 31 figs. incl. diags., graphs, 32 tables, 1959, 20 refs.

Changes of acidity taking place during carbonization of both fresh and oxidized coals were studied to secure new information on the processes of coal carbonization, coal oxidation, and on the effect of oxidation on coking properties.

Three high-volatile Illinois coals and a low-volatile eastern coal were ground to minus 40-mesh particle size, and separate portions of these were subjected to air oxidation for 64 days at 25°C. ("natural" oxidation) and for 47 days at 110°C. ("forced" oxidation). Laboratory-scale carbonization of the fresh and oxidized coals was performed at temperatures ranging from 200°C. to 600° C. Variations in the contents of acidic structural groups during oxidation and carbonization of these coals were measured by means of potentiometric titration with sodium aminoethoxide in ethylenediamine, using antimony electrodes. Chemical analyses and infrared spectra were also obtained.

All the coals studied behaved as dibasic acids in ethylenediamine. Natural oxidation caused an initial decrease in acidity, followed by a slow rise. Forced oxidation caused a substantial rise in acidity, especially in the more strongly acid groups. Formation of carboxyl groups was indicated in the high-volatile coals.

In the carbonization of the high-volatile coals the original acidic groups began to decrease at temperatures above 200°C. The greatest decrease was from 400° to 500° C., but very weak groups were detected between 300° and 500° C., and their number and the temperature range over which they were found varied considerably in the fresh and oxidized coal carbonization products. The tendency of weak acidic groups to appear seemed to diminish as the rank of the coal increased. They were not found in the carbonization of the low-volatile coal. - Auth.

1-2391. Landis, E. R. COAL RESOURCES OF COLORADO: U. S. Geol. Survey, Bull. 1072-C, p. 131-232, 2 maps (1 in pocket), chart (in pocket), graph, 16 tables, July 1959, 77 refs.

Previous estimates of the coal reserves of Colorado were made on a regional basis and included large tonnages of coal which are too deeply buried to be considered minable. They also included reserve estimates for areas in which available information will not allow a detailed estimate to be made. The coal reserves of Colorado, as presented in this report, were estimated on an individual-bed basis in all parts of the state where it was feasible; and they are classified according to the abundance and reliability of the available data and according to the characteristics of the coal.

About 28% of the area of Colorado, or about 29,600 sq. mi., is underlain by coal-bearing rocks. Of this area, about 20,600 sq. mi. may contain minable reserves of coal at depths less than 3,000 ft. However, available data allow a detailed estimate to be made for only 5,276 sq. mi. of the state. In that area, which is about 18% of the total area underlain by coal-bearing rocks, a total of about 81,785 million tons of coal is estimated to have been originally present. Of the total, 0.11%, or about 90 million tons, is anthracite and semianthracite; 77.28%, or about 63,203 million tons, is classed as bituminous; and 22.61%, or about 18,492 million tons, is subbituminous coal.

Before Jan. 1, 1956, about 493 million tons of coal had been mined in Colorado. Applying a 50% recoverability factor, about 80,799 million tons of coal is still available for mining, and about 40,399 million tons of recoverable coal is estimated to be present in Colorado in the 5,276 sq. mi. for which information is adequate. --Auth.

1-2392. Banks, Luis M. OIL-COAL ASSOCIATION IN CENTRAL ANZOÁTEGUI, VENEZUELA: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 8, p. 1998-2003, 2 graphs, Aug. 1959, 6 refs.

A quantitative evaluation is made of the volumetric distribution of oil and coal in the Tertiary Oficina formation of central Anzoátegui, Venezuela. The concomitant variations indicate that oil and coal are causally or genetically related in the area. The relationship additionally questions the theory that all oil is of marine origin. --M. Russell.

14. ENGINEERING GEOLOGY

See also: Areal and Regional Geology 1-2192; Geophysics 1-2278.

1-2393. National Research Council of Canada, Associate Committee on Soil and Snow Mechanics. PROCEEDINGS OF THE FIFTH MUSKEG RESEARCH CONFERENCE, 4 MARCH 1959: Its: Tech. Memo., no. 61, 85 p., 29 figs. incl. illus., maps, diags., graphs, June 1959, 24 refs.

Topics covered in these proceedings included road construction over organic terrain, determination of engineering properties of the organic material, vehicles and trafficability, and drainage. A list of the 112 persons attending is appended. Seven papers were given and 2 films were shown. Papers are as follows:

REPORTS:

Evel, Jean. An Outline of Current Muskeg Research in Canada, p. 2-12.

The Radforth Classification System is cited as useful in dealing with muskeg exploration. Several examples of recent procedures used in the construction of tank farms, railways, hydro pylons, highways, and access roads are given. The Canadian Army's "Rat" is cited as an example of a vehicle which can traverse muskeg well.

MECHANICAL PROPERTIES; ROAD CONSTRUCTION:

Brawner, C. O. Summary of "The Principle of Preconsolidation in Highway Construction Over Muskeg," p. 13-15.

This paper describes how satisfactory foundations can be obtained in muskeg by consolidating the peat with surcharge during the construction period by an amount as much or more than would occur in 25 years without surcharge.

Anderson, K. O., and R. A. Hemstock. Relating the Engineering Properties of Muskeg to Some Problems of Fill Construction, p. 16-25.

Results are reported of a test program designed 1) to compare values of shearing strength with a vane tester to calculated values at failure conditions, and 2) to investigate the use of membranes designed to reduce the loss of strength in fill by excluding excess water. Some of the results are: the moisture content of muskeg is the best indicator of the behavior of material; vane-test shear strength determinations match computed shearing resistance closely; polyethylene plastic and asphalt impregnated glass fiber membranes failed to prevent moisture from entering the test fill.

MacFarlane, Ivan C. An Evaluation of Some Roads Over Muskeg in Northern Ontario, p. 26-30.

All shear failures were reported in areas underlain by a layer of fluid clay or silt. It was found that muskeg type has little relation to whether a road succeeds or not, except that roads tend to stand up better in muskeg types having large tree growth.

VEHICLES AND TRAFFICABILITY:

Thomson, J. G. Vehicle Mobility Performance in Muskeg: A Second Report, p. 31-54.

"Development of the Canadian North, a subject of growing national interest, must in part await the development of better forms of transport. The estimated 500,000 sq. mi. in muskeg terrain in the N. combined with the scarcity of roads make essential the early development of special purpose muskeg vehicles.

Good progress has been made in the last 11 years in classifying muskeg, and some progress has been made in determining its mechanical properties. Limited travel is now possible through the use of special purpose tracked vehicles which have been built without adequate design data.

A program to provide data which can be used to optimize muskeg vehicle designs began in 1957. The results of the second phase of this program are presented in this report. It is shown that vehicle performance in muskeg is directly related to the mechanical properties of the muskeg. Further, it is shown that good design practice for tracked vehicles expected to operate in snow, sand, soft clays, and loams is also good practice for muskeg vehicles. All indications are that muskeg mechanics is properly a part of conventional soil mechanics.

It may therefore be said that an extensive literature is now available to the muskeg vehicle designer. The literature of the science of soil mechanics and of the art of vehicle design are both applicable."--Auth.

Introductory Remarks to Film - Field Trials of Muskeg Transport Vehicle in Alberta, p. 55-57.

FORESTRY DRAINAGE:

Carlson, W. S. Aspects of Muskeg as it Affects the Forestry Industry, p. 58-61.

This paper presents the problems of logging and transportation in connection with the harvesting of black spruce, Canada's most valuable pulp species, which grows in muskeg.

Cuthbertson, J. A. Aspects of Ditching and Drainage Techniques in Muskeg Areas, p. 62-74.

The 2 principal methods by which muskeg areas could be drained are defined and described. They are: 1) underground or tile drainage for agricultural purposes, and 2) open drainage by ditching for forestry development, mining, or assisting to develop transportation means. Known procedure and available machinery for carrying out such operations are described; particular attention must be given to learning and preserving the natural drainage channels in muskeg areas.

GENERAL DISCUSSION: p. 75-78.

An incorporation of comments on the papers presented. --M. Russell.

1-2394. Fluhr, Thomas W. ENGINEERING GEOLOGY OF THE CITY OF NEW YORK WATER SUPPLY SYSTEM: New York Acad. Sci., Trans., v. 21, no. 6, p. 463-468, Apr. 1959, 5 refs.

The scope of the work of the Geology and Soils Division of the Board of Water Supply of the City of New York includes subsurface investigation of dam sites, tunnels, shaft sites, and intake and outlet works; investigations for the construction of highways and bridges which must be built to replace those submerged by new reservoirs; assistance in planning of tunnels, with special attention to problems of roof support and tunneling through faults; investigating the geologic aspects of property acquisition and claims of property owners; and maintaining a soils testing laboratory. --M. Russell.

15. MISCELLANEOUS

1-2395. King, Ruth Reece, and others. BIBLIOGRAPHY OF NORTH AMERICAN GEOLOGY, 1956: U. S. Geol. Survey, Bull. 1075, 554 p., 1959.

The current volume lists some 4,000 publications that appeared during 1956 dealing with the North American continent, Greenland, the West Indies, and other adjacent islands, Hawaii, Guam and other island possessions, but not the trust territories of the United States. A few articles published before 1956 and not included in previous volumes are also listed. Articles by American authors published in foreign journals are cited if they deal with North American localities or are of a general nature. Articles by foreign authors on North America are included regardless of place of publication; those of a general nature are included if they appeared in North American journals.

Publications are listed alphabetically by author, with full title and other bibliographical information. Following the bibliography is a detailed subject index. --From auth. introd.

1-2396. McCrossan, Robert George, and others, eds. ANNOTATED BIBLIOGRAPHY OF GEOLOGY OF THE SEDIMENTARY BASIN OF ALBERTA AND OF ADJACENT PARTS OF BRITISH COLUMBIA AND NORTHWEST TERRITORIES, 1845-1955: 499 p., map, Calgary, Alberta Society of Petroleum Geologists, 1958.

A bibliography of more than 1,500 references, comprising 202 pages, occupies the first half of the book. The items in most instances are accompanied by a brief statement of content. Each reference is also given a reference number which enables the reader to orient the area discussed on the grid of the National Topographic System. A copy of this map is included. The bibliography is followed by a list of unpublished theses covering areas in Alberta. A second major division is the subject index. Entries in this section include author's name, year published, and a grid reference to exact area discussed. The paleontological index is particularly exhaustive, and the listing is by genera. The location index makes possible the assembling readily of data on a region or of a specific area on the grid. Lastly there is a list of place names, together with their grid locations. --From rev. by J. V. Howell.

1-2397. U. S. Geological Survey, Foreign Geology Branch. THE GEOLOGICAL SURVEYS OF THE WORLD: Am. Geol. Inst., AGI Data Sheet 14, 2 p. in GeoTimes, v. 4, no. 2, p. 19-20, Sept. 1959.

The names and addresses are given for geological surveys and departments of mines in 114 countries. Countries are listed alphabetically under North America (including Greenland), Central America and Caribbean Islands, South America, Europe, Africa, Middle East, Asia, Australia and Pacific Islands. --A. C. Sangree.

1-2398. Patnode, H. Whitman, and Robert P. Trump. ADDITION OF PERSPECTIVE TO CONTOUR MAPS: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 8, p. 2009-2012, 2 maps, Aug. 1959.

The effect of a third dimension can be added to a contour map by a process first used by the Japanese Hydrographic Office in 1954. Contours are printed in a light or dark tone depending on whether the part of the topographic feature being portrayed is presumed to be in the light or shadow of a source from the upper left corner of the map. A means of adding this kind of perspective to existing contour maps is described. --M. Russell.

1-2399. Miller, Lewis. GEOLOGY TRANS-CANADA: GeoTimes, v. 4, no. 2, p. 12-13, 32, illus., Sept. 1959.

A series of 8 lectures was broadcast during March-May 1958 on the Canadian Broadcasting Corporation's "University of the Air" program, entitled, An Introduction to Geology. The response to the lectures by Dr. David M. Baird of the University of Ottawa indicates that this is an effective method of presenting the elements of geology to a large and diverse audience. The text of these talks was published in 1959 and is listed as GeoScience Abstracts 1-1580. --M. Russell.

1-2400. Muehlberger, William R. GEOLOGY ON CLOSED CIRCUIT TV AT TEXAS U.: GeoTimes, v. 4, no. 2, p. 21, illus., Sept. 1959.

Closed circuit television instruction is to be used as an aid in teaching elementary physical geology at the University of Texas. A principal advantage is the ability of television to present a close-up view of demonstrations to large classes. --M. Russell.

1-2401. Eiseley, Loren C. CHARLES LYELL: Sci. American, v. 201, no. 2, p. 98-106, port., illus., Aug. 1959.

Charles Lyell, born in Scotland in 1797, founded modern historical geology. His greatest contribution was probably the theory of uniformitarianism, set forth at length in a 3-volume work Principles of Geology. In arguing against a contemporary theory of his day, progressionism, Lyell came close to the theory of evolution as expressed by Darwin and Wallace but nevertheless he rejected that theory until late in his career. Lyell's work in explaining the orderliness of geologic history gave Darwin and Wallace the necessary "time" for their theory to be practical; his role in the development of the theory of natural selection, while tangential, is very great. He died in 1875. --M. Russell.

1-2402. Weeks, Lewis G. UNEMPLOYMENT AND OUR MORE BASIC PROBLEMS: GeoTimes, v. 4, no. 2, p. 8-11, 34, 36, 38, Sept. 1959.

Geologists, perhaps more than any other scientific group, are presently suffering an unemployment slump. The results of a survey of 60 colleges granting geology degrees show that only 52% of the June graduating students had obtained jobs. An oversupply of crude oil and poor hiring methods in the past have contributed to the present situation, but the principal difficulties appear to result from low professional standards, poor training in allied fields of science, and a failure on the part of industry to realize the economic soundness of maintaining qualified geologists during slack periods. Licensing is necessary in fields involving public safety and health but would not be the answer to the geologist's problem. --M. Russell.

1-2403. National Academy of Sciences-National Research Council. RADIOACTIVE WASTE DISPOSAL INTO ATLANTIC AND GULF COASTAL WATERS: Its: Pub. 655, 37 p., 5 maps, 2 graphs, 6 tables, 1959, 13 refs.

A study has been made of the feasibility of using selected areas in the Atlantic and Gulf of Mexico coastal waters of the United States as receiving ground for the disposal of packaged, low level radioactive wastes.

The primary objective of the study has been to provide an estimate of the rate of return of radioactive substances to man, arising from stated rates of disposal into the coastal areas. The limiting rate of disposal has been taken as that which through a combination of physical and biological processes will return the radioactivity to man at a rate equal to the maximum permissible rate of ingestion of a given radionuclide in drinking water.

These rates were based on the occupational MPC's (maximum permissible concentration) given in Handbook 52. The MPC's for the general population according to recent information should be lowered by a factor of 10. The revised MPC's of some isotopes may be reduced even further. It is believed, however, that the conservative assumptions contained in this report offset the effects of these reductions in MPC values.

The present practice of using 55-gal. steel drums as disposal canisters containing the waste mixed with concrete is estimated to provide containment of approximately 10 years, during which time radioactive decay will have destroyed all radioisotopes (based upon Oak Ridge National Laboratories current rate of production and shipment) to below hazardous levels, with the exception of Sr 90, Cs 137, and possibly Co 60.

Coastal circulation is not known in sufficient detail to provide quantitative estimates of the rate of transport of a contaminant out of any of the areas selected as possible disposal sites. These estimates can be made only after detailed circulation studies have been completed. Especially lacking is knowledge of the circulation of bottom waters. Nevertheless, several areas stand out as being probably unsuited as disposal sites. They are the coastal estuaries and bays, and the regions immediately seaward of these areas. Shoreward transport along the bottom in these regions would tend to intensify the rate of return of a contaminant to man. Also, a region SE. of Long Island, extending out to approximately 50 fathoms, appears to have restricted bottom circulation during the summer months and therefore might accumulate larger quantities of contaminant than other coastal areas.

A theoretical study of the dilution of contaminant

by turbulent mixing processes has been made. The results of the study provide the means of evaluating the effects of changing environmental parameters and of various disposal methods on the dilution of a contaminant. Because of the assumptions made, all estimates of concentration at a given distance and time are probably higher by at least a factor of 10 than would actually exist in practice. Even with these conservative assumptions calculations show that given a rate of disposal of 100 curies per year of uncontained waste into water 30 m. deep with a current of 5 mi. per day, the maximum concentration of waste which will appear 1 km. (approximately 5/8 mi.) from the disposal site will be 2×10^{-7} μc/ml., a concentration that is lower than the maximum permissible concentration of Sr 90 in drinking water. Sr 90 has the lowest MPC value of all radioisotopes listed. In addition, the relationships between both relative concentration and time after release and distance from the disposal site, under the unlikely condition that no current will aid in diffusive mixing, have been developed.

In arriving at recommended disposal rates the interaction of a contaminant with suspended solids and bottom sediments has been neglected. It was found impossible to make a quantitative estimate of the magnitude of this reaction. Neglecting this factor puts a certain factor of safety in the recommendations, as sorption onto bottom sediments within the disposal area will provide additional containment, thus allowing for further destruction of the contaminant by radioactive decay. In the case of disposal into areas productive in commercially important shellfish (oysters, clams, etc.) the sorption onto bottom deposits may become a potential hazard rather than a safety factor. This situation has been eliminated by selecting areas in which no shell fisheries occur.

The return of radioactive wastes to man by ingestion of contaminated marine food products is considered to be the most likely potential source of hazard that could result from disposal into coastal waters. An estimate has been made of the maximum permissible concentration of each of several radioisotopes in sea water, below which contamination of marine food products will not lead to greater than allowable intake by humans whose sole source of protein is fish. This estimate was derived from the maximum permissible concentration of the isotopes in drinking water, from which was computed the maximum weekly intake of each of the isotopes; the weekly ingestion rate of fish, taken as 1.5 kg., a value that is high compared with the per capita value for this country but has been taken on the assumption that some individuals obtain all of their protein from fish; and the extent to which marine organisms can concentrate the various isotopes within themselves above the level in their environment. The most hazardous isotope in the list is Sr 90, for which the maximum permissible concentration in sea water is 8×10^{-7} μc/ml., which by coincidence is identical with the MPC value for drinking water.

Suggested disposal areas have been chosen in an attempt to minimize conflict with submarine cable operation, as well as the purely mechanical problems connected with fisheries activities. --Auth. summ.

AUTHOR INDEX